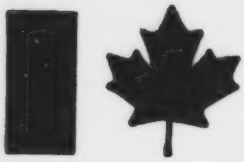
REQ. NO. 2-9155

CONTRACT REPORT NO. OSQ83-00040



Supply and Services Canada

DSS File No. 26SQ. 23440-2-9155

ENGINEERING PROPOSAL FOR IDENTIFICATION OF UNDERGROUND EQUIPMENT DEVELOPMENT POTENTIAL AND THE INFLUENCE OF MINE DESIGN

DECEMBER , 1982

THE CM GROUP

ENGINEERS
CONTRACTORS
DRILLERS
SERVING THE MINING INDUSTRY.

223 pp

MICROMEDIA

SUPPLY AND SERVICES CANADA

DSS FILE NO. 26 SQ. 2340-2-9155

ENGINEERING PROPOSAL FOR IDENTIFICATION OF UNDERGROUND EQUIPMENT DEVELOPMENT POTENTIAL AND THE INFLUENCE OF MINE DESIGN

DECEMBER 1982

PREPARED BY: P. White, P.Eng.

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MAS SECRETARIAT

SUPPLY AND SERVICES CANADA

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EQUIPMENT DESIGN AND MANUFACTURE

PAPERS

Telephone: (416) 792-2700
Telex: 06-97762

CANADIAN MINE SERVICES LTD.

1595 CLARK BOULEVARD, BRAMPTON, ONTARIO L6T 4C1

December 14, 1982

The Secretary
Supply Administration
Supply and Services Canada
Room 1-355
Place du Portage, Phase III
11 Laurier Street
Hull, Quebec
K1A 0S5

Dear Sirs:

RE: DSS FILE NO. 26 SQ. 23440-2-9155
ENGINEERING PROPOSAL FOR IDENTIFICATION OF
UNDERGROUND EQUIPMENT DEVELOPMENT POTENTIAL
AND THE INFLUENCE OF MINE DESIGN

Canadian Mine Services Ltd. is pleased to submit for your consideration our proposal to undertake an engineering study related to the identification of underground equipment development potential and the influence of mine design, as required by the CANMET staff of the Department of Energy, Mines and Resources.

As the largest mining contracting group in Canada, Canadian Mine Services Ltd. has current mining operations from Newfoundland to British Columbia which provide access to the most recent developments in underground mining technology. Our firm also employs a group of highly-talented professional engineers with proven operational and engineering backgrounds, specifically to provide consulting services to clients in the public and private sector, related to the underground mining, mechanical and electrical engineering disciplines. We are currently working on major engineering and contracting projects for clients such as Atomic Energy of Canada Limited, Denison Mines Limited and Newfoundland and Labrador Hydro. Our list of clients previously served includes

DSS SECRETARY
MAS SECRETAIRE

major firms across Canada, the USA and Overseas. We have all of the required expertise within our company to undertake the in-depth study outlined in your Statement of Work, to complete this project in the desired time and to satisfy the project requirements of DSS and CANMET.

Our submission includes a technical proposal which summarizes the approach which we recommend, based on our intimate first-hand working knowledge of the major hard-rock mining operations across Canada. Despite the fact that Canadian mining companies are involved in equipment development, the contracting business of our firm has been built on the innovative design, manufacture and application of mining equipment to improve the working conditions and productivity associated with underground operations. Our success as a company and our growth over the past two decades has been directly related to the modification of mining machinery to suit new and unusual mining problems.

We have assembled a project team fully qualified to accomplish the objectives of this project, with a proven track record in conceptual and detailed studies. The members of our team have worked in close collaboration on a large number of projects in recent years and are able to integrate the required project input from all disciplines.

We thank you for requesting this proposal from Canadian Mine Services Ltd. and would look forward to undertaking this project on your behalf.

Yours truly,

CANADIAN MINE SERVICES LTD.

P. White

P. White, P.Eng.
Chief Mining Engineer
Eastern Canada Operations

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/jr

Supply and Services Canada | Approvisionnements et Services Canada

REQUEST FOR PROPOSAL — DEMANDE DE PROPOSITION

Page 1 Of De 7

Date of Solicitation – Date de Sollicitation
November 8,1982

Solicitation closes – Sollicitation expire
At – À 10:00 A.M. On – Le Dec. 17, Nov. 24, 1982
EST

DSS File No. – Dossier MAS N°
26SQ.23440-2-9155

Delivery Date req. at dest. – Date de livr. demandée
August 31, 1983

INSPECTION
☒ CONSIGNEE CONSIGNATAIRE ☐ DSS MAS ☐ DND/DAD MDN/DAC

Address enquiries to (Name)
Adresser les demandes de renseignements à (Nom)
Ms. Gaetane Dagenais (26SQ)

Area Code & Tel. No.
Code régional et n° tél. (613/819) 997-7399

Canadian Mine Services Ltd.
1595 Clark Blvd.
Brampton, Ont.
L6T 5C1

Destination

If your name and/or address is incorrect, show corrections on reverse side. Si votre nom et (ou) adresse est inexact inscrivez les corrections au verso.

RETURN ORIGINAL – RENVOYER L'ORIGINAL

Submit this form with your proposal. (Return envelope provided.) Return to The Secretary, Supply Administration, Department of Supply and Services, Room 1-335, Place du Portage, 11 Laurier Street, Hull, Quebec K1A 1C9

Renvoyer cette formule avec votre proposition, en utilisant l'enveloppe fournie, au Secrétaire, Administration des Approvisionnements, Ministère des Approvisionnements et Services, Pièce 1-335, Place du Portage, 11, rue Laurier, Hull (Québec) K1A 1C9

Item Article	Description	Price Prix

TITLE

IDENTIFICATION OF UNDERGROUND EQUIPMENT DEVELOPMENT POTENTIAL AND THE INFLUENCE OF MINE DESIGN

IMPORTANT

Please note Clause 8.0 which sets out conditions relating to:

i) Acceptance of telex/telegraphic Bids.
ii) Method of requesting time extension to closing date.
iii) Validation of date and time of respondent RFP's.

1.0 REQUIREMENT

1.1 The Department of Energy, Mines and Resources, has a requirement for an in-depth investigation of current and potential developments in hardrock mining equipment and their probable effects on mine development, mining methods and related mine design. The requirement is further detailed in Appendix "A" attached hereto and forming part of this Request for Proposal.

INSTRUCTIONS

1. *Quote in Canadian currency.*
2. *Municipal taxes are not applicable. For Provincial taxes see reverse.*
3. *All prices are to include applicable Canadian customs duties, excise taxes and federal sales tax.*
4. *All prices are to include packing, packaging and all delivery charges F.O.B. destination(s) specified herein.*

1. *Les prix doivent être indiqués en devises canadiennes.*
2. *Les taxes municipales ne s'appliquent pas; pour les dispositions sur les taxes provinciales, voir au verso.*
3. *Tous les prix indiqués doivent comprendre les droits de douane canadien: la taxe d'accise et la taxe fédérale de vente.*
4. *Tous les prix doivent comprendre les frais d'emballage, d'empaquetage et de livraison F.A.B. à la destination indiquée ci-dessus.*

Delivery Offered Livraison proposée	Federal Sales Tax Taxe de vente fédérale	Total Estimated Cost Coût total estimatif	Country of Foreign Content Origine T.E.E.	Value of Foreign Content Valeur éléments étrangers
August 31, 1983	Nil	$83,250.00	Canada	Nil

Name and Title of person authorized to sign (Type or Print)
Nom et titre de la personne autorisée à signer (Dactylo ou majuscules)

This proposal is submitted upon the Terms and Conditions set out herein and on the reverse side hereof.

Cette proposition est présentée suivant les conditions exposées dans les présentes et au verso des présentes.

Peter White — NAME - NOM
Chief Mining Engineer
Eastern Canada Operations — TITLE - TITRE

SIGNATURE

DSS 0116 (6/78)

CORRECTED CORPORATE NAME AND ADDRESS
LA RAISON SOCIALE ET L'ADRESSE CORRIGÉES

TERMS AND CONDITIONS

1. Any proposal submitted by a potential supplier may be returned in whole or in part as an offer to purchase without negotiation.

2.a) Payment will be made only in Canadian currency unless otherwise specified herein and no interest will be paid on any sum overdue.

b) Materiel will be new production of current manufacture.

3. Prices are to be submitted in accordance with the requirements set out herein.

4.a) Proposals to be considered must be received by the OFFICE, designated on the reverse side of this page, not later than the proposal closing time. Proposals that are received later than the closing time will be returned unopened except in the case of proposals that are delayed in the mail and there is acceptable evidence of abnormal delay. In the case of proposals delayed in the mail they will be accepted after closing time provided:

i) the Post Office postmark, or;

ii) the Post Office receipt, in the case of registered mail or special delivery.

demonstrates that the proposal was deposited in the mail system at least 48 hours before closing time for proposals mailed within Canada, or 96 hours before closing time for proposals mailed from outside Canada.

NOTE: Postage meter dates are not normally cancelled by an Official Post Office Cancellation Stamp (Postmark) and therefore are not acceptable as evidence of timely mailing.

b) Proposals submitted by telegram or telex are acceptable provided they are received prior to the time specified for closing of proposals, contain the proposal reference number and closing date, contain sufficient pricing data to allow evaluation, such as, unit prices, sales tax, duty, terms, etc., and that signed copies of the formal proposal are furnished in confirmation of the telegraphic or telex proposal within a reasonable time.

5.a) The provisions of General Conditions DSS-1026B in the case of requirements being provided on behalf of the Department of National Defence, or General Conditions DSS 1026 (S100B) in the case of all other requirements, will apply to any contract entered into as a result of this proposal in the event that no other General Conditions are rendered applicable.

b) You acknowledge to have received a copy of the applicable DSS General Conditions.

6. The applicable Department of Labour (Federal Government) labour provisions established by Order-in-Council P.C. 1954-2029 of December 22, 1954, a copy of which you acknowledge to have received, and all amendments thereto shall apply, as hereinafter provided, and form part of any contract entered into as a result of this proposal. The said labour provisions will apply only in the event that General Conditions DSS-1026 (A or B) or DSS-1026 (S100A or S100B) apply to this proposal.

7. Where no other packaging is specified, the following shall apply.

a) The supplies provided under the terms of any resultant contract shall be so packed as to permit the application of the lowest available less than carload/truckload freight classification and to ensure safe arrival at destination.

b) For Department of National Defence requirements.

"Preparation for delivery. If performed in Canada, shall be in accordance with the latest issue of the Canadian Forces Packaging Specification Canadian Forces Transportation Packaging Order CC-CIV-PAK (CFTPO-CC-CIV-PAK). If performed in the U.S.A. Preservation, Packaging and Packing shall be to level C as defined in the latest issue of Federal Standard No. 102 (Fed Std 102) and marking shall be in accordance with the latest issue of Federal Standard No. 123 (Fed Std 123). If performed in the UK, preservation, packaging and packing shall be manufacturer's Trade Export Packaging or such packaging of a higher grade as recommended by the British Ministry. Marking shall be in accordance with DSS(L) Appendix M".

8. You hereby certify that the price/rate quoted is based on costs computed in accordance with Costing Memorandum DSS 1031 (latest issue), a copy of which you acknowledge to have received.

9. **Note re Foreign Content:**

Enter the value of foreign content in Canadian funds and country of origin in the space provided on reverse. The value of foreign content shall not include the cost of processing material of foreign origin in Canada by your firm or by your subcontractors, or any element of your overhead or profit, duties, sales tax and transportation in Canada.

10. The contractor shall not invoice or collect any ad valorem retail sales tax levied by the province in which the goods or services are delivered to Federal Government Departments and Agencies under authority of the following provincial sales tax licences:

Newfoundland	32243-0-09
Prince Edward Island	OP-10000-250
Nova Scotia	U84-00-03172-3
New Brunswick	P87-60-01648
Quebec	Q-398-SS-3921-1-P
Ontario	11708174G

In all other provinces, provincial retail sales taxes do to apply to goods or services delivered to the Federal Government under this contract.

11. Definitions:

a) *Inspection DND/QAD* – Indicates that inspection will be carried out by the Quality Assurance Division of the Department of National Defence.

b) *Inspection DSS* – Indicates that inspection will be carried out by the officer of the Department of Supply and Services designated as the inspection authority in the body of the contract.

DSS-MAS 5118-1 (8/76)

CONDITIONS

1. Toute proposition présentée par un fournisseur éventuel peut être retournée en entier ou en partie à titre d'offre d'achat sans négociation.

2.a) Sauf indication contraire, le paiement sera effectué uniquement en devises canadiennes, et aucun intérêt ne sera versé sur un montant échu.

b) Il doit s'agir d'articles neufs issus d'une production courante.

3. Les prix doivent être indiqués conformément aux exigences énoncées dans les présentes.

4.a) Pour être prises en considération, les propositions doivent parvenir au bureau désigné au verso avant l'heure et la date de clôture indiquées. Les propositions en retard seront retournées non décachetées, sauf dans le cas de celles qui ont été retardées pendant leur acheminement par la poste, des preuves acceptables de ce retard indu étant faciles à trouver. Ces propositions seront donc acceptées après la date de clôture si:

i) le cachet de la poste, ou;

ii) le récépissé de la poste, dans le cas du courrier recommandé ou de envois exprès,

prouve que la proposition a été mise à la poste, au Canada, au moins quarante-huit heures avant l'heure de clôture, ou, à l'extérieur du Canada, au moins quatre-vingt-seize heures avant l'heure de clôture.

REMARQUE: Les dates des machines à affranchir ne sont pas ordinairement annulées par le timbre d'oblitération officielle de la poste (marque postale) et ne sont donc pas acceptables pour prouver date de l'envoi a été fait suffisamment à l'avance.

b) Les propositions envoyées par télégramme ou télex seront acceptées si elles sont reçues avant la date limite fixée, si elles indiquent le numéro de référence de la proposition et la date de clôture, si elles fournissent les données permettant d'évaluer les coûts, notamment les prix unitaires, la taxe de vente, les droits de douane, les conditions etc., et si des copies signées de la proposition officielle sont produites dans un délai raisonnable en guise de confirmation de la proposition télégraphiée ou envoyée par télex.

5.a) Il est entendu que les clauses des Conditions générales DSS 1026B, dans le cas des commandes passées pour le ministère de la Défense nationale, ou des Conditions générales DSS 1026 (S100B), pour tous les autres cas, s'appliqueront à tout contrat passé à la suite de cette proposition, à moins qu'il ne soit indiqué que d'autres Conditions générales s'appliquent.

b) Vous reconnaissez avoir reçu une copie des Conditions générales du MAS qui sont applicables.

6. Les dispositions du ministère fédéral du Travail concernant la main-d'oeuvre, promulguées en vertu du décret C.P. 1954-2029 du 22 décembre 1954, dont vous reconnaissez avoir reçu un exemplaire, et toutes les modifications feront partie intégrante de tout contrat passé à la suite de cette proposition. Lesdites dispositions concernant la main-d'oeuvre s'appliqueront que si les Conditions générales DSS-1026 (A ou B) ou DSS-1026 (S100A ou S100B) s'appliquent elles aussi à cette proposition.

7. A défaut d'autres spécifications concernant l'emballage, on devra se conformer aux règles suivantes:

a) Les produits fournis aux termes de tout contrat conclu à la suite de cette proposition seront emballés de façon à permettre l'application de la classe de marchandises en charges incomplètes la plus basse possible et à assurer leur arrivée intacts à destination.

b) Fournitures commandées pour le ministère de la Défense nationale:

"Préparation pour la livraison: S'il est effectué au Canada, l'emballage doit être conforme à l'édition la plus récente des Normes d'emballage des Forces canadiennes, Ordonnance des Forces canadiennes sur le transport et l'emballage CC-CIV-PAK (OFCTE-CC-CIV-PAK). S'ils sont effectués aux Etats-Unis, la conservation, l'emballage et l'emballage devront être de la catégorie C, définie par l'édition la plus récente de la Norme fédérale nº 102 (Fed Std 102) et le marquage devra être conforme à l'édition la plus récente de la Norme fédérale nº 123 (Fed Std 123). S'ils sont effectués au Royaume-Uni, la conservation, l'emballage et l'empaquetage devront être conformes à la norme d'emballage d'exportation du fabricant ou à toute autre norme d'emballage de haute qualité recommandée par le ministre britannique. Le marquage devra être conforme à l'appendice M de la formule DSS (L)".

8. Vous certifiez par la présente que les prix ou les tarifs indiqués ont été calculés en se fondant sur des coûts établis conformément au Mémoire sur le calcul du prix de revient, formule DSS 1031 (dernière version), dont vous reconnaissez avoir reçu un exemplaire.

9. **Remarque au sujet de la teneur en éléments étrangers**

Inscrire la valeur, en devises canadiennes, de la teneur en éléments étrangers et le nom du pays d'origine dans la case prévue à cet effet au verso. Ce montant ne doit pas comprendre le coût de transformation de ce matériel au Canada par votre entreprise ou par vos sous-traitants, ni aucun élément de vos frais généraux ou bénéfices, ni droits, taxes de vente ou frais de transports au Canada.

10. L'entrepreneur ne doit ni facturer ni percevoir de taxes de vente au détail sur la valeur, imposées par la province ou les biens et services doivent être fournis aux ministères et organismes fédéraux dans le cadre des permis suivants:

Terre-Neuve	32243-0-09
Île-du-Prince-Édouard	OP-10000-250
Nouvelle-Écosse	U84-00-03172-3
Nouveau-Brunswick	P87-60-01648
Québec	Q-398-SS-3921-1-P
Ontario	11708174G

Dans toutes les autres provinces, la taxe provinciale de vente au détail s'applique bel et bien aux biens et services devant être livrés au gouvernement fédéral dans le cadre du présent contrat.

11. Définitions:

a) *inspection MDN/DAQ* – signifie que l'inspection sera faite par la Division de l'assurance de la qualité du ministère de la Défense nationale.

b) *inspection MAS* – Indique que l'inspection sera effectuée par un agent du ministère des Approvisionnements et Services désigné comme l'inspecteur dans le contrat.

SUPPLY AND SERVICES CANADA

1.0 INTRODUCTION

Supply and Services Canada, responsible for administering the Federal contracting out policy related to research and development, has requested this proposal from Canadian Mine Services Ltd. to undertake the second phase of an in-depth study of the identification of underground equipment development potential and the influence of mine design. This project, developed by the Canada Center for Mineral and Energy Technology (CANMET), is intended ultimately to promote the further development, by Canadian firms, of mining equipment for the hard-rock mining industry, to improve productivity and performance, and to reduce costs of mining underground orebodies. It is expected that new techniques and equipment will not only increase safety and provide improved economies of underground hard-rock mining, but that their implementation could revolutionize the requirements for mine development, thus eliminating many existing unit operations commonly found in underground mining.

The first part of this project has been completed and consisted of a literature search and a survey of mining operations to identify the most promising areas where equipment development could influence mining operations and mine design. The second part of this project, now to be conducted, involves the analysis of potential equipment applications in hard-rock mines, based on visits to selected mines, equipment manufacturers, mining contracting firms and mines inspectorates across Canada. These site visits are the key aspect of the second phase of this project to ensure that the analysis and evaluations of the potential equipment applications are based on comments and ideas from actual mine operators who are daily faced with the tasks of hard-rock mining.

This proposal has been prepared by Canadian Mine Services Ltd. to document the approach which we propose to take to accomplish the objectives of the second phase of this project.

2.0 COMPANY BACKGROUND

Canadian Mine Services Ltd. is the largest mining contracting organization in Canada, with subsidiary companies operating in the United States and Puerto Rico. A comprehensive range of services related to underground hard-rock mining are provided by the company in fields such as engineering and project management, contract mining and construction, drilling, research, development and manufacturing. The company has provided over two decades of service to mining companies and Provincial utilities in the development of underground rock excavations. In recent years, a progressively more technical involvement, resulting in a broader contract base of integrated activities has been developed. The application of recent technological developments in rock excavation and the mechanization of mining operations has prompted our organization to provide specialized equipment and personnel. This includes the development of specialized mining techniques as well as the integration of equipment design and construction to achieve safe and economical development and mining of underground hard-rock orebodies.

The engineering and project management group has professional, technical and support staff with experience in the following engineering disciplines:

Geology	Mining
Structural	Mechanical
Electrical	Civil
Surveying	Metallurgical

Numerous engineering projects across Canada, the United States and Overseas have been undertaken for:

Underground Mines	Open Pit Mines
Placer Deposits	Oil Sands
Milling	Mine and Mill Construction
Tunnels	Nuclear Waste Storage

SUPPLY AND SERVICES CANADA

A wide variety of engineering reports have been prepared for mining and related industries as well as government agencies. The assignments have ranged from projects requiring conceptual designs, to detailed engineering analysis of existing operations searching for innovative improvements. Reports are prepared for a wide range of client requirements including technical engineering, as well as cost estimation and mineral economics. Typical examples are:

Preliminary Reports
Intermediate Reports
Feasibility Studies
Senior Financial Reports
Special Purpose Reports

All reports are presented in a form and style to clearly communicate information and conclusions to the client with supporting data and calculations to facilitate decision making.

To support the work carried out by the engineering and project management department, as well as to provide supporting services to the contract operations of the company, an experienced staff of design and drafting personnel are maintained. Engineers and technical staff, skilled in surveying, mine design, structural, civil and mechanical design work collaborate on a wide range of projects. In addition to the detailed design of working drawings, this group is also skilled in the presentation of artistic illustration and the fabrication of scale models of underground structures.

Computing facilities are maintained both on an in-house and on a time sharing basis to facilitate the preparation of work by the engineering staff. The company also has access from in-house terminals to a number of technical data-base systems to permit computer searches for information on a wide variety of topics.

One of the major strengths of the engineering department is the on-going exposure to the contracting organization of Canadian Mine Services. It is in

this contracting area where costs are accepted on a risk basis and where the need for on-going innovation is the key to profitable operations.

A fully referenced technical library is maintained including documents which have been prepared by the engineering staff over a number of years and reflect the involvement of the group in a wide range of technical assignments. In addition, information is available from public sources as well as a number of research documents which have been prepared on subjects of interest to the company.

Additional information on the activities of Canadian Mine Services Ltd. is contained in Appendix A as part of this proposal.

3.0 PROJECT METHODOLOGY

3.1 SOURCES OF INFORMATION

One of the principal objectives of this study is to solicit responses from experienced mine operating companies concerning the potential benefits which would result from the implementation of advanced mining equipment and technology. The larger mining companies generally have sufficient financial and personnel resources to examine, and to utilize, new and innovative approaches to underground hard-rock mining. One major reason for this is that their ore reserves and projected mine life is measured in decades, rather than in years, resulting in a long term perspective on the part of the mine management. These large operations are relatively less sensitive to the developmental costs normally associated with the trial and implementation of new technology, since the long term payoff may be quite attractive.

In the present economic climate, however, several of the largest mining companies in Canada are experiencing severe financial hardship. Many mining operations, such as Inco Ltd., have suspended operations until late in 1983 and have eliminated staff positions in areas related to new technology. For this reason, some of the most likely sources of information otherwise pertinent to the objectives of this study may not be readily available.

Similarly, mines which have existing infrastructure will not likely find it economically attractive to substantially upgrade their mining technology unless the return on their investment is sufficiently high to cover the costs of debt financing and to provide a safe measure of risk relative to uncertainties of successful implementation of the project, metal prices and markets, and financing costs. In the realities of the current Canadian mining industry, few large mine operating companies will be in a position to consider potential development in mining equipment and technology. Their focus remains on reducing overhead and development costs, and improving the grade of ore mined, to maintain the costs of production below the selling price of metals.

To achieve a satisfactory response to the solicitation of information from current mining operations, Canadian Mine Services Ltd. recommend that the selected mining operations for site visits include as many as possible of the underground hard-rock operating mines in Canada with daily operating capacities of 2000 TPD or greater. A list of operating mines which satisfy this criterion is contained in Table 3.1.

In addition to these existing mine operations, a number of major potential hard-rock mine operations of major scale are currently in the exploration, feasibility assessment and design stages. Most of these properties have been carefully examined and mine designs have been established to determine the feasibility of developing these mineral deposits into operating mines. It is these large scale underground hard-rock mine operations which have the highest potential of successfully implementing advanced mining technology. These operations do not have existing infrastructure or other limitations to impede the utilization of advanced technology. In fact, in order for these new mines to compete with existing producers, they must employ the most recent developments in technology. For new operations, modern technology will result in a better return on investment than current technology. Since these potential operations will likely be the first users of advanced equipment design, and since these operations are most likely to feature innovative mine designs, Canadian Mine Services Ltd. recommend that these companies be included in the survey of mining operations. A list of potential producing companies who should be asked to contribute their ideas to this project is included in Table 3.2.

Within Canada, another major group which continuously strives to attain the highest levels of performance and productivity are mining contracting organizations. Since these firms operate in a highly competitive industry, serving the needs of mining companies for mine development and construction, contractors are usually among the earliest users of new mining technology. Contractors, such as Canadian Mine Services Ltd., undertake research into new equipment development and frequently propose innovative mine designs to prove savings to their clients, thus developing business for their services. A list of the major mining contractors who should be interviewed is included in Table 3.3.

Table 3.1 LIST OF CURRENT MINING OPERATIONS EXCEEDING 2000 TPD CAPACITY

Company Name	Location	Daily Operating Capacity (TPD)	Principal Metals	Mining Methods
Inco Limited	Sudbury, Ontario	40,000+	Ni, Cu	All types
Gaspe Copper	Murdochville, Quebec	33,800	Cu	Room and Pillar
Rio Algom	Elliot Lake, Ontario	15,000	U	Room and Pillar
Denison	Elliot Lake, Ontario	14,000	U	Room and Pillar
Texas Gulf	Timmins, Ontario	13,500	Pb, Zn, Cu	Sublevel Caving, Blasthole
Sherritt Gordon	Lynn Lake, Manitoba	13,000	Cu, Zn	Sublevel Blasthole with delayed backfill
Falconbridge Nickel	Sudbury, Ontario	12,000	Ni, Cu	Cut and Fill, Blasthole
Brunswick	Bathurst, N.B.	10,000	Pb, Zn, Cu	Cut and Fill
Algoma Ore	Wawa, Ontario	10,000	Fe	Open Stoping
Cominco Ltd.	Kimberley, B.C.	10,000	Pb, Zn, Ag	Open Stoping, Room and Pillar
Hudson Bay Mining & Smelting	Flin Flon, Manitoba	8,500	Zn, Cu, Ag	Open Stoping, Cut and Fill, Shrinkage
Inco Ltd.	Thompson, Manitoba	6,500	Ni, Cu	Cut and Fill
Pamour Porcupine	Timmins, Ontario	6,000	Au	Cut and Fill, Shrinkage, Open Stoping
Granduc	Stewart, B.C.	5,000	Cu	Open Stoping
Noranda Mines	Manitowadge, Ontario	5,000	Pb, Zn, Cu	Blasthole with delayed Fill
Noranda Mines	Matagami, Quebec	4,500	Cu, Zn	Sublevel Blasthole, Sublevel Retreat

Table 3.1 LIST OF CURRENT MINING OPERATIONS EXCEEDING 2000 TPD CAPACITY/Continued

Company Name	Location	Daily Operating Capacity (TPD)	Principal Metals	Mining Methods
Heath Steele	Newcastle, N.B.	4,000	Zn, Pb, Cu	Open Stoping, Delayed Backfill
Corp. Falconbridge Copper	Opemiska, Quebec	3,200	Cu, Au	Cut and Fill
Mattabi	Ignace, Ontario	3,000	Zn, Pb, Cu	Cut and Fill
Wesfrob Mines	Tasu, B.C.	3,000	Fe, Cu, Au Ag	Blasthole
Miobec	Chicoutimi, Quebec	2,300	Nb_2O_5	Open Stoping
Lamaque Mining Co.	Val d'or, Quebec	2,100	Au	Cut and Fill
Billiton	St. Stephen, N.B.	2,000	Sb, Mo, W	Open Stoping

Table 3.2 LIST OF FUTURE MINING OPERATIONS TO EXCEED 2000 TPD CAPACITY

Company Name	Location	Project
Dome Mines Ltd.	Timmins, Ontario	Detour Lake
Dome Mines Ltd.	Timmins, Ontario	Dome Project
Westmin Resources	Buttle Lake, B.C.	H W Mine
Amax Inc.	MacMillan Pass, Yukon	MacTung
Amax Inc.	Smithers, B.C.	Yorke Hardy
Cyprus Anvil	Mackenzie, B.C.	Cirque Project
Cyprus Anvil	Faro, Yukon	Grum Project
Newmont Mining	Revelstoke	Trout Lake Project
Hudson Bay Mining and Smelting	MacMillan Pass, Yukon	Tom Claims
Placer Mining	Howards Pass, Yukon	Cygnus Project

SUPPLY AND SERVICES CANADA

Table 3.3 LIST OF MINING CONTRACTORS

1. Canadian Mine Services Ltd.
   Brampton, Ontario

2. Cementation Ltd.
   Brampton, Ontario

3. Dynatec Mining Ltd.
   Richmond Hill, Ontario

4. J.S. Redpath Ltd.
   North Bay, Ontario

5. MacIssac Mining and Tunnelling Ltd.
   Sudbury, Ontario

6. Thyssen Mining Construction of Canada Ltd.
   Regina, Saskatchewan

Many equipment manufacturers are also leading the efforts to improve the safety and efficiency of mine operations. Although the views expressed by manufacturers may be somewhat less objective than those of the mine operation personnel, their ideas will contribute substantially to the success of this project. Those manufacturers recommended by Canadian Mine Services Ltd. as being seriously involved in innovative equipment design are listed in Table 3.4.

In addition to the mine operators, contractors and manufacturers, the views of the mines inspectorate and provincial electrical utilities will contribute measureably to the objectives of this project. Those who have serious involvement in major underground hard-rock mining operations are listed on Tables 3.5 and 3.6 respectively.

In summary, the sources of opinion and information to be solicited regarding the identification of the potential development of underground mining equipment and the influence of this development on mine design should be comprehensive in nature. For a project of the intended scope, every effort should be made to solicit the views of a wide spectrum of the mining industry. By no means should the informtion be gathered from a small and restricted group of organizations. Canadian Mine Services Ltd. have past and current working relationships with virtually every organization listed in the previous Tables of recommended contacts. Many of these recommended sources have been at one time or another, clients of our firm on mine development and mine design assignments. Current employees of Canadian Mine Services Ltd. have been drawn from the ranks of these organizations. We are in a position to contact the recommended sources for information and to ensure that the requirements of this project merit their serious attention.

Table 3.4 LIST OF EQUIPMENT MANUFACTURERS

Company	Location	Products
Asea	St. Laurent, Quebec	Electrical hoisting and haulage equipment
Atlas Copco	Dorval, Quebec	Drilling and haulage equipment, raise boring equipment
Cubex Ltd.	Winnipeg, Mantioba	Drilling equipment
Dux Machinery	Montreal, Quebec	Haulage equipment
Dorr Oliver	Orillia, Ontario	Hoisting and haulage equipment
Forano Inc.	Plessisville, Quebec	Conveying systems
Gatx-Fuller	Scarborough, Ontario	Crushing and conveying equipment
Jarvis Clark	North Bay, Ontario	Drilling and haulage equipment
LKAB	Markham, Ontario	Haulage systems
Rexnord Canada	Willowdale, Ontario	Conveying systems
Tamrock	Sudbury, Ontario	Drilling equipment

SUPPLY AND SERVICES CANADA

Table 3.5 LIST OF MINES INSPECTORATE

1. R.R. March
Chief Inspector of Mines
Department of Labour
St. Johns, Newfoundland

2. B. Connell
Acting Director
Occupational Health and Safety Commission
Fredericton, N.B.

3. Gilles Neron
Director
La Commission de Sante & Securite au Travail
Quebec, Que.

4. P. McCrodan
Director
Mining Health and Safety
Toronto, Ontario

5. R. Glassford
Chief Mining Engineer
Department of Mines
Winnipeg, Manitoba

6. T. Carter
Chief Inspector of Mines
B.C. Mines Dept.
Victoria, B.C.

SUPPLY AND SERVICES CANADA

Table 3.6 LIST OF ELECTRICAL UTILITIES

1. New Brunswick Electric Power Commission
   Fredericton, N.B.

2. Hydro Quebec
   Quebec, Quebec

3. Ontario Hydro
   Toronto, Ontario

4. Manitoba Hydro
   Winnipeg, Manitoba

5. B.C. Hydro
   Vancouver, B.C.

3.2 QUESTIONNAIRE

In order to obtain the maximum benefit from the time and effort to be devoted to the solicitation of views from people involved in the mining industry, it is imperative that the Questionnaire be properly prepared. The format recommended by Canadian Mine Services Ltd. is to subdivide the Questionnaire into specific subject sections directed towards the principal items of interest in this study, as well as a general section to describe the overall background of each information source.

The Questionnaire to be prepared should be comprehensive in nature, to the degree possible, and should be correlated with other related Questionnaires required by Federal agencies such as Statistic Canada, the Ontario Mineral Score, a computer analysis of the Mineral Industry of Ontario produced by the Ontario Ministry of Natural Resources, and other similar sources of information.

Private firms, such as the Canadian Mining Journal and the Northern Miner Press, also collect production information from operating mines and these may provide a useful source of corroborating information.

To ensure that sufficient information is requested and obtained from the mine operating sources, and that the information received can be readily analyzed and transcribed into a report format to satisfy the objectives of this report, the preparation of the Questionnaire must receive adequate importance in the project. If the Questionnaire is inadequately prepared, the results of the project are likely to be unsatisfactory. For this reason, Canadian Mine Services Ltd. have attached considerable importance to this aspect of the project, and recommend that the Questionnaire should receive close scrutiny before being issued for field use.

To illustrate the range of topics which should be covered, a list of sample Questionnaire topics has been prepared in draft format to outline the approach to Questionnaire preparation favoured by Canadian Mine Services Ltd. for this project. This attachment is preliminary in nature and is included for illustrative purposes. The final Questionnaire will be a very comprehensive document.

SUPPLY AND SERVICES CANADA
DRAFT FORMAT
SAMPLE QUESTIONNAIRE TOPICS

1. Firm Name: _____
Address: _____
_____

Representative Name: _____
Title: _____

Phone: _____ Telex: _____

2. Description of mining operations:

Mine Name: _____

Date of initial production: 19___

Mine Capacity: _____ TPD _____ TPW _____ TPY

Mine Operating Rate: _____ TPD _____ TPW _____ TPY

Operating Shifts/Week Production _____ Shifts
Development _____ Shifts
Hoisting _____ Shifts

Principal Minerals: Pb, Zn, Cu, Au, Az, Mo, Ni, Fe, U

Principal Mining Methods: Shrinkage
Cut and fill using mechanized methods
Room and Pillar
Open Stoping
Sub-level Blasthole
Large Diameter Blasthole
Vertical Crater Retreat
Sub-level Caving

SUPPLY AND SERVICES CANADA
DRAFT FORMAT
SAMPLE QUESTIONNAIRE TOPICS

3. DESCRIPTION OF MINING EQUIPMENT

3.1 LATERAL DEVELOPMENT EQUIPMENT

Track

Jacklegs
Long Toms
Pneumatic Jumobs, _____ boom
Hydraulic Jumbos, _____ boom
Rocker Shovel Loader, _____ m^3 bucket
Other Loaders, _____ m^3 bucket capacity
Locomotives. _____ type
Cars, _____ type, _____ m^3 capacity

Trackless

Jacklegs
Pneumatic Jumbos, _____ boom
Hydraulic Jumbos, _____ boom
Scrapers, _____ kW
Diesel LHD, _____ m^3 bucket
Electric LHD, _____ m^3 bucket
Trucks, _____ m^3 capacity
Rockbolt Jumbo, _____ type

3.2 RAISE DEVELOPMENT EQUIPMENT

Open
Cribbed
Longhole Drop Raising
Alimak, Electric, Diesel, Pneumatic
Raise Borer

3.3 STOPING EQUIPMENT

Jacklegs
Stopers
Rockbolting Jumbo
Uppers Jumbo
Fan Jumbo
Longhole Jumbo
Large Diameter Drill Jumbo
Blasthole Loading Jumbo
Scrapers
Rocker Shovel Loader
Tracked Loader

SUPPLY AND SERVICES CANADA
DRAFT FORMAT
SAMPLE QUESTIONNAIRE TOPICS

Diesel LHD
Electric LHD

3.4 ORE TRANSPORTATION EQUIPMENT

Diesel LHD
Electric LHD
Truck
Grizzly
Orepass
Crusher
Conveyor
Trolley Locomotive
Battery Locomotive
Railcars
Skips
Hoists

4. MINE ELECTRIFICATION

Incoming Electrical System Capacity		kV	kW
Primary Substation Capacity		kV	kW
Surface Electrical Distribution Voltage		kV	
Underground Electrical Distribution Voltage		kV	
Surface Electrical Consumption		kV/a	
Ventilation System Electrical Consumption		kV/a	
Dewatering System Electrical Consumption		kV/a	
Hoisting System Electrical Consumption		kV/a	
Ore Handling System Electrical Consumption		kV/a	
Other Underground Electrical Consumption	_____	kV/a	
Total Electrical Consumption		kV/a	
Mine Air Heating		J/a	
Underground Diesel for Consumption		l/a	
Compressed Air Consumption		m^3/a	
		kW/a	

SUPPLY AND SERVICES CANADA
DRAFT FORMAT
SAMPLE QUESTIONNAIRE TOPICS

Describe mine operations which have potential for electrification or for hydrid power system (diesel/electric, trolley/battery) and estimate changes to existing energy consumption.

5. ORE LOADING AND TRANSPORT SYSTEM

Could a portable hard rock crusher improve or simplify your ore handling operations?

What throughput tonnage would be required?

What would be the maximum lumps size of the feed material?

What would be the size of the crushed product?

How many hours per week would the crusher operate?

Where would a portable crusher be located?

What development savings would result from use of portable hard rock crushers?

What manpower savings would result from the use of portable hard rock crushers?

Which of the following high capacity or continuous ore handling systems could apply to your operation:

- Belt conveying
- Pneumatic Conveying
- Hydraulic Conveying

Describe potential applications for high capacity or continuous ore handling systems and identify channels to existing operating conditions.

SUPPLY AND SERVICES CANADA
DRAFT FORMAT
SAMPLE QUESTIONNAIRE TOPICS

6. AUTOMATION OF UNDERGROUND EQUIPMENT

Which of the following operations are presently automated at your operation:

Hoisting
Conveying
Dewatering
Ventilation

Which of the following operations could be automated at your operation:

Hoisting
Conveying
Dewatering
Ventilation
Crushing
Haulage
Loading
Drilling

Describe potential applications for the automation of mining equipment and identify changes to existing operating conditions.

7. HIGH SPEED MECHANIZED DEVELOPMENT

Which of the following areas at your operation could be improved by utilizing high-speed mechanized development:

Shaft Sinking: - drilling
- blasting
- mucking

Raising - drilling
- blasting
- mucking
- boring

SUPPLY AND SERVICES CANADA
DRAFT FORMAT
SAMPLE QUESTIONNAIRE TOPICS

Level
Development
- drilling
- blasting
- mucking
- haulage
- boring

Describe potential applications for the implementation of high-speed mechanized development and identify changes to existing operating conditions.

8. MONITORING OR REMOTE CONTROL SYSTEMS

Which of the following areas at you operation could be improved by utilizing monitoring or remote control systems:

Rock mechanics
Ventilation
Dewatering
Drilling
Mucking
Haulage
Ore Handling
Fire Protection
Equipment Status and Location
Boring Machines
Electrical Motor Control

Describe potential applications for the implementation of monitoring or remote control systems and identify changes to existing operating conditions.

SUPPLY AND SERVICES CANADA
DRAFT FORMAT
SAMPLE QUESTIONNAIRE TOPICS

9. RETAINING WASTE ROCK UNDERGROUND

What quantity of waste rock is provided annually at your operation?

How is this waste rock handled?

Disposed of on surface.
Disposed of underground.
Used as road bed material.
Used as stope backfill.
Hoisting
Conveying
Trucking

Describe potential applications for retaining waste rock underground and identify changes to existing operating conditions.

3.3 SITE VISITS

Once the Questionnaire has been prepared and a trial use of the Questionnaire by a few selected firms has proven successful, the source organizations previously listed will be contacted. The procedure visualized for this phase of the project is outlined as follows:

a) Contact by mail the selected firms and organizations to solicit cooperation in obtaining the required information.

b) Contact by phone to confirm requirements for site visits and prepare a travel itinerary.

c) Issue Questionnaire by mail three weeks prior to site visits for review by recipient firms and organizations.

d) Travel to selected sites, meet with senior mine operating staff, assist in completion of the Questionnaire, discuss pertinent comments and suggestions.

e) Follow-up by phone for residual information and input with two weeks of site visit.

The following travel itinerary listed in Table 3.7 has been prepared to demonstrate the scope of travel visualized by Canadian Mine Services Ltd. to properly achieve the response from mine operators and related organizations on the topics of importance to this study. In fact, the site visits will be undertaken by a number of our senior staff who are, by virtue of their existing responsibilities, intimately familiar with client organizations in various regions of the country. Specifically, the Western contacts will be made by Vancouver office staff. Contacts in the Maritimes, Quebec, Ontario and the Maritimes will all be made by individuals currently responsible for directing the operations of Canadian Mine Services Ltd. in each of these regions. This will facilitate communications relative to the project Questionnaire, since the regional representatives of our company have an intimate knowledge of the

mine operating personnel, equipment, mining methods and infrastructure at each operating mine in their respective territories.

Canadian Mine Services Ltd. do not visualize any difficulties in contacting the key operating staff personnel at the various mine operating organizations previously listed. In most cases, personal contacts exist between our firm and those to be visited for the purpose of this study. Our personal contacts and knowledge of the mine operating staffs, which has been developed as a result of our contracting and consulting activities enables us to gain entry to all of the recommended sources of information. The national reputation of Canadian Mine Services Ltd., as well as the personal reputations of the members of the project team will ensure that the requirements of this project have credibility and will be acknowledged as a matter of high priority.

SUPPLY AND SERVICES CANADA

Table 3.7 TRAVEL ITINERARY

	Route	Purpose	
1.	Toronto - Ottawa - Toronto	To confer with Scientific Authority regarding project requirements	
2.	Toronto - Ottawa - Toronto	To review Questionnaire and procedure with Scientific authority prior to initiating mine site visits	
3.	Toronto - Fredericton	Visit to:	N.B. Dept. of Mines Brunswick Billiton Heath Steele
4.	Fredericton - Quebec	Visit to:	Hydro Quebec Quebec Mines Inspectorate
5.	Quebec - Murdochville - Quebec	Visit to:	Gaspe Copper
6.	Quebec - Montreal	Visit with:	Atlas Copco Asea Dux Machinery Forano
7.	Montreal - Val d'Or - Montreal	Visit with:	Lamaque Niobec Opemiska Matagami
8.	Montreal - Sudbury	Visit with:	Inco Falconbridge Tamrock Jarvis Clark J.S. Redpath

SUPPLY AND SERVICES CANADA

Table 3.7 TRAVEL ITINERARY/Continued

	Route	Purpose	
9.	Sudbury - Timmins	Visit with:	Texas Gulf Detour Pamour Porcupine Dome Mines Ltd.
10.	Timmins - Sault Ste. Marie	Visit with:	Canmet - Elliot Lake Denison Rio Algom Algoma Ore Geco
11.	Sault Ste. Marie - Dryden	Visit with:	Mattabi
12.	Dryden - Winnipeg	Visit with:	Department of Mines
13.	Winnipeg - Thompson	Visit with:	Inco Ltd.
14.	Thompson - Lynn Lake	Visit with:	Sherritt Gordon
15.	Lynn Lake - Flin Flon	Visit with:	H B M & S
16.	Flin Flon - Winnipeg - Victoria	Visit with:	B.C. Mines Department Westmin Resources
17.	Victoria - Tasu	Visit with:	Wesfrob
18.	Tasu - Vancouver - Kimberley	Visit with:	Cominco Ltd.
19.	Kimberley - Vancouver	Visit with:	Amax Ltd. Cyprus Anvil Newmont Mining

SUPPLY AND SERVICES CANADA

Table 3.7 TRAVEL ITINERARY/Continued

	Route	Purpose
20.	Vancouver - Toronto	Visit with: Firms in Toronto area
21.	Toronto - Ottawa - Toronto	Review progress of work with Scientific Authority
22.	Toronto - Ottawa - Toronto	Submit draft report to Scientific Authority
23.	Toronto - Ottawa - Toronto	Submit final report to Scientific Authority

3.4 ANALYSIS AND DOCUMENTATION

Following the receipt of the Questionnaire responses from the mine operating firms and related organizations, the information will be categorized by each of the major subjects for analysis of the information received. This information will be directly transcribed into a technical description of potential equipment applications at typical mines and will illustrate the influence of potential applications on mine design. This will be followed by an analysis of the technical and economic feasibility of the potential developments with supporting graphs, tables, photographs and charts.

Since the topics of interest to this study are not necessarily mutually inclusive, it is the recommendation of Canadian Mine Services Ltd. that each subject area be documented in individual documents. This will facilitate ultimate utilization of the reports by enabling interested readers to focus their attention on subject matters of major importance to themselves. Of necessity, a summary volume will be prepared to highlight the results of the study, but detailed documentation will be found only in the respective subject volumes. Each subject volume will be similar in content, the organization of each report including the following items:

Table of Contents

Abstract

Introduction

Background Information and Study Objectives

Summary of Results and Conclusions

Description of Current Mine Practice Related to Subject Area

Description of Potential Equipment Applications

Analysis of Technical Feasibility of Potential Applications and the Influence on Mine Design

Economic Analysis of Potential Applications

Supporting Graphs, Tables, Photographs, Illustrations

List of References

Appendix Presentation of Questionnaire Responses

Reviews with the Scientific Authority and the CANMET staff will be conducted by the senior project team members who will be available for consultation at the discretion of the Scientific Authority.

4.0 REQUEST FOR DEVIATIONS

No deviations are requested from the requirements of this project.

5.0 PROJECT TEAM

The project team will be located in the Head Office of Canadian Mine Services Ltd. at Brampton, Ontario.

P. White, P.Eng., Chief Mining Engineer, Eastern Canada Operations, will lead the project and will be responsible for the overall control of the project and for liaison with the Scientific Authority. Mr. White has been designated as a Consulting Engineer by the Association of Professional Engineers of Ontario and has over fifteen years of experience in the hard-rock mining industry. He has worked on hard-rock mining projects across Canada and overseas for mining contractors and mining companies as an equipment operator, supervisor and as an engineer. He has been responsible for consulting projects for a number of clients over the past three years and has directed conceptual as well as detail mine design projects. Mr. White has personally undertaken several consulting assignments dealing with the analysis of applications for new technological developments in the mining industry.

J. Tatak, P.Eng., Senior Vice President, Eastern Canada Operations, will be the Principal responsible for this project and will ensure that the project is conducted in a fashion consistent with good engineering practices of the standard accepted by Canadian Mine Services. Mr. Tatak has over twenty five years of hard-rock mining experience in Canada and Overseas and has been instrumental in the development of novel mining equipment and mining methods for a number of consulting and contracting projects. On several project sites, Mr. Tatak was responsible for the successful and profitable implementation of new mining techniques to ore zones which would have been uneconomical to mine by traditional methods.

R. Crawshay, Senior Vice President, Technical Services, will contribute significantly to the project based on several decades of personal experience in the modification, adaptation and development of mining and ancillary equipment for use in underground hard-rock mines. Mr. Crawshay directs the on-going Research and Development activities carried out by Canadian Mine Services Ltd. as part of the operations of our firm, including current work on advanced high speed mechanized mining systems.

T. Mann, P.Eng., Mining Engineer, will be one of the principal authors of the project. He will be involved in the questionnaire preparation, will undertake the site visits to selected mines, and will prepare the resulting reports for this project. Mr. Mann has over fifteen years of hard-rock mining experience as a supervisor and as an engineer in Canada, Europe and Africa. He has been the principal author of a number of mine design studies and has been heavily involved in the actual design and construction and operation of underground mines, including recent work for Atomic Energy of Canada Limited.

R. Clarke, P.Eng., Mining Engineer, will be another of the principal authors of this project. He will assist Mr. Mann in the preparation of the reports documenting the information obtained as a result of the site visits. Mr. Clarke has over fifteen years of underground hard-rock mining experience as a supervisor and as an engineer at mines across Canada. He has been involved in the design of a new 1,300,000 tonnes per year underground mining operation in Eastern Canada and has recently acted as project engineer on a major hard-rock underground development project being constructed for Newfoundland and Labrador Hydro.

Other senior staff who will assist and participate in this project are **A. Malkin, P.Eng.,** Chief Mechanical Engineer, and **A. Steward, P.Eng.,** Chief Mining Engineer, Western Canada Operations. Both of these men have considerable expertise in the development of underground hard-rock mines and will contribute significantly during the various phases of this project.

The technical support staff of **H. Hoffman, W. Marshall and G. Lundy** will also be involved in the project to compile the results of the information gathered during the site visits and in the preparation of reports for this project. These men are knowledgeable of the requirements for underground hard-rock mine design, construction and development, and will contribute directly to accomplishing the objectives of this project.

A Functional Organization Chart is shown in Figure 5.1 to identify the departments of Canadian Mine Services Ltd. which will contribute to this project.

SUPPLY AND SERVICES CANADA

The Project Team Organization Chart is shown in Figure 5.2 to depict the structure of the team responsible for this project.

Additional staff members who will review and comment on the projects as part of our internal review process are not identified as part of the project team but are included as part of Appendix A to this proposal.

Figure 5.1 **Canadian Mine Services Ltd., Functional Organization Chart**

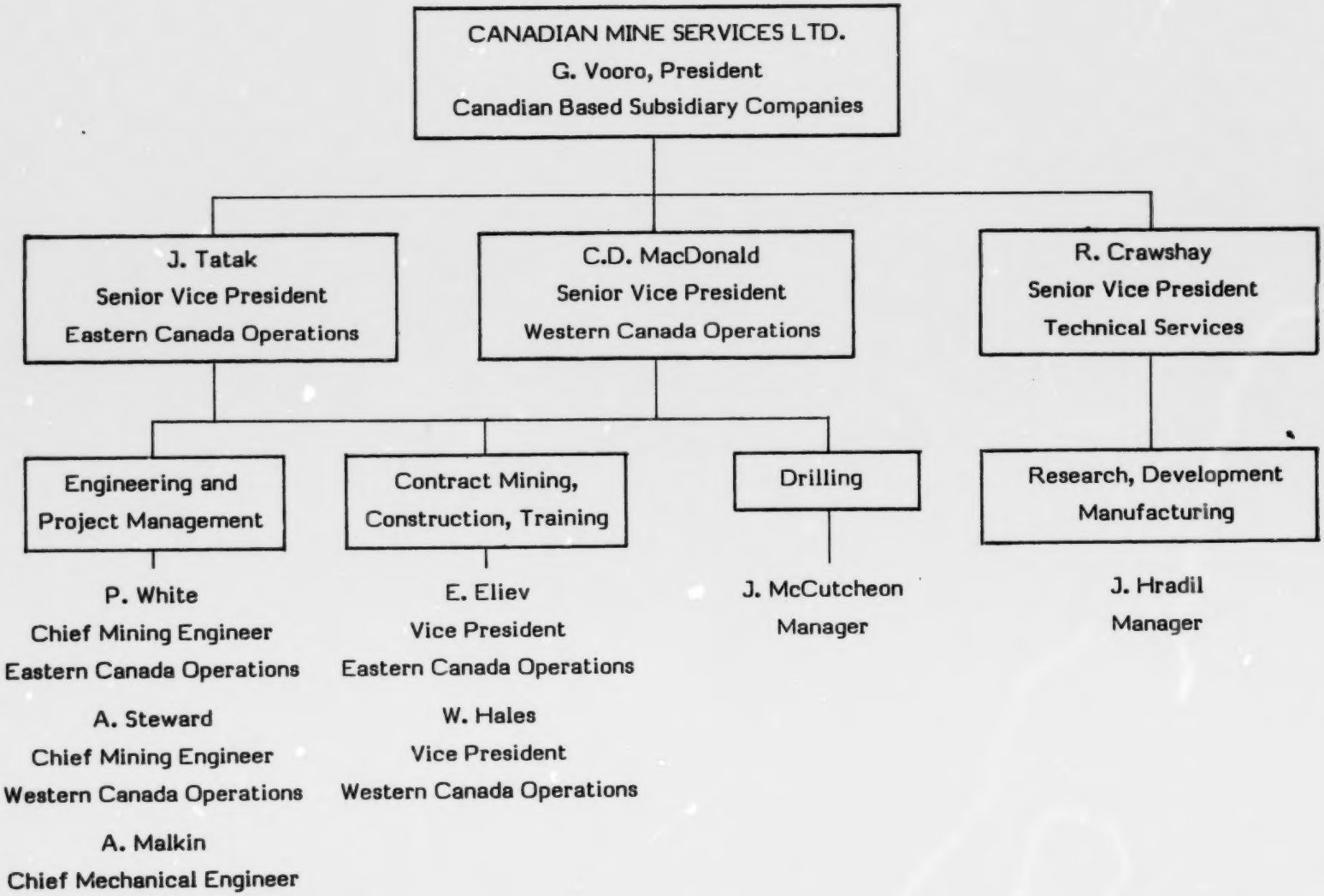
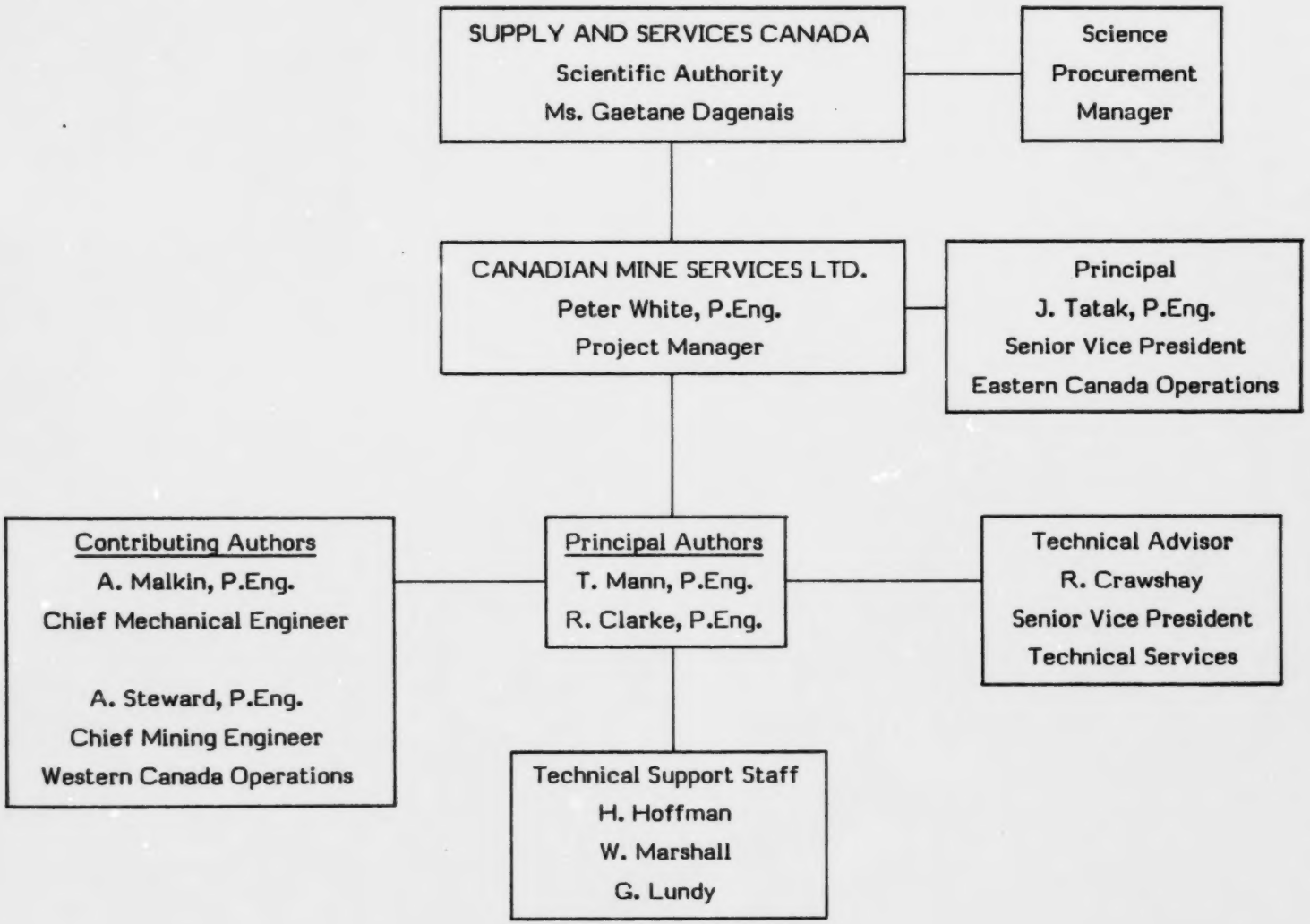


Figure 5.2 **Project Team Organization Chart**



SUPPLY AND SERVICES CANADA

PETER WHITE, P. Eng.
Chief Mining Engineer
Eastern Canada Operations

Peter White graduated from Queen's University with a degree in Mining Engineering and later returned to complete a Master's Degree in Business Administration. His background includes technical, supervisory, and administrative duties on several mining projects across Canada and overseas.

Following graduation, Peter joined J.S. Redpath Ltd. and was responsible for project engineering on a number of underground construction and development contracts and supervision of raise boring operations. He later worked as mine engineer for Lynx Canada Exploration Ltd. and as Chief Engineer for Consolidated Churchill Copper Corporation Limited.

Prior to joining the Engineering Group of Canadian Mine Services in 1979, Peter was with Mattagami Lake Mines Ltd., Lyon Lake Division at Ignace, Ontario where he was Project Engineer during the construction and development of the Lyon Lake and Mattabi underground operations.

As Chief Mining Engineer, he is responsible for technical and economic evaluations related to various mining and construction projects, as well as the development of engineering practices required to support the activities of the engineering group. Peter has been recently supervising a number of major conceptual and detailed engineering projects for clients such as Amax Inc., Gulf Canada Resources Ltd. and Atomic Energy of Canada Limited.

Peter has been designated as a Consulting Engineer by the Association of Professional Engineers of the Province of Ontario, and is a member of the Canadian Institute of Mining and Metallurgy, the Project Management Institute and the American Association of Cost Engineers.

SUPPLY AND SERVICES CANADA

JOE TATAK, P. Eng.
Senior Vice President
Eastern Canada Operations

Joe Tatak is a graduate of Ostrava University, Czechoslovakia with a degree in Mining Engineering. His background covers all phases of the company's activities and spans more than 25 years.

His assignments have included work on reserve estimates, evaluations, exploration work, economic feasibility studies, expansion programs, new shafts, open pit mining and development planning. These studies have concerned such minerals as coal, clay, bentonites, kaolin, potash, uranium, and lead-zinc-copper ores in Europe and Canada.

Prior to imigrating to Canada to join Brunswick Mining and Smelting Corp. Ltd. (Noranda Group), Joe held various positions in Czechoslovakia including mine captain, general mine foreman, chief engineer and mine manager. He later worked as chief mine engineer with International Minerals and Chemicals Co. Ltd. in Saskatchewan before joining Canadian Mine Services in 1976.

Joe has since held positions of increasing responsibility and is currently responsible for all of the company activities in Eastern Canada. He has been involved in feasibility studies for new mining ventures, property evaluations, mine design and shaft planning. Joe has been instrumental in the development of innovative mining methods and equipment to mine orebodies that would have been uneconomical to mine by conventional methods.

Mr. Tatak is a Registered Professional Engineer in the Provinces of British Columbia and Ontario and member of the Canadian Institute of Mining and Metallurgy.

SUPPLY AND SERVICES CANADA

RICHARD CRAWSHAY
Senior Vice President, Technical Services
Canadian Mine Services Ltd.

Richard Crawshay has over 30 years experience in the design and manufacture of machinery, coupled with first hand knowledge of the operation and maintenance of a wide range of mining equipment.

He became involved with mining in 1951 at the Canadian Exploration Ltd. Mine at Salmo, B.C., one of the early trackless operations. There, he became responsible for the maintenance and overhaul of all the underground diesel powered equipment. This was a period of trial for the new trackless mining method and much experience was gained by exposure to equipment largely adapted from surface machines by suppliers whose knowledge of underground conditions was limited.

Mr. Crawshay became deeply involved in the modification and adaption of this equipment to meet the demands made upon it, and contributed to the design of some of the first trackless mine drilling jumbos.

In 1955 he joined Letson & Burpee Ltd., Engineers and Machinery Manufacturers of Vancouver, B.C., who served the mining and other major industries in Western Canada. During fifteen years with this company, he became Works Manager, and in later years, was involved in the design of products and production machinery with particular emphasis on mechanization.

He joined Canadian Mine Services Ltd. in 1972 to establish a Research and Development group. Since then he has contributed to the development of our Superdrill diamond drill, and in-line-loader, trackless haulage and support vehicles, and shaft sinking equipment.

He is dedicated to the development of safer, more productive mining and diamond drilling machinery, which will match the innovation demonstrated by the planning and operational groups within the Company.

SUPPLY AND SERVICES CANADA

TIM MANN, P. Eng.
Mining Engineer

Tim Mann graduated from Nottingham University, England, in 1968 with an Honors Degree in Mining Engineering. His background includes supervisory and engineering assignments on three continents.

After graduating, Tim joined Nchanga Consolidated Copper Mines Limited of Zambia as an Assistant Mining Engineer. At Konkola Mine in Zambia, he held the positions of Shiftboss, Planning Engineer, Mine Captain, and Assistant Underground Manager. The work involved production, planning, development and capital operations, particularly relevant to the copper mining industry, including the specialized mine dewatering and grouting techniques used at Konkola Mine.

In 1975, Tim joined Gypsum Industries Limited of Ireland as Mines Manager. Apart from the responsibility of the management of two gypsum mines, he was involved in costing projects, development planning, and feasibility studies.

Tim joined Canadian Mine Services Ltd. in October 1980 as a Mining Engineer. He is responsible for various consulting projects, which have included the selection, assessment and design of tunnelling and mining methods. Tim has also been involved in the economic and technical evaluation of mine properties, and has been instrumental in developing the application of a micro-computer for engineering studies and engineering evaluations. Most recently Tim has been involved with the Underground Research Laboratory conceptual design for Atomic Energy of Canada Limited and is now co-ordinating the mining, mechanical and structural engineering work for the detailed engineering phase of the same project.

He is a member of the Association of Professional Engineers of the Province of Ontario and a member of the Canadian Institute of Mining and Metallury. He is also a Chartered Engineer in the United Kingdom and a member of the Institution of Mining and Metallurgy.

SUPPLY AND SERVICES CANADA

ROBERT W.D. CLARKE, P. Eng.
Mining Engineer

Bob Clarke graduated in 1966 from Nova Scotia Technical College with a B. Eng. degree in mining engineering. His background includes supervisory and engineering positions throughout Canada.

From 1966 to 1971 he worked at the Con Mine in Yellowknife, N.W.T. becoming Mine Engineer in 1969. From 1971 to 1977 he worked at the Sullivan Mine in Kimberley, B.C. as a member of the mine operations team. He started as Contract Engineer, becoming Assistant Operating Superintendent and then Technical Superintendent. From 1977 to 1979 he was a Scientific Advisor to the Atomic Energy Control Board.

Apart from the normal day-to-day mine operating experience, Bob joined Canadian Mine Services Ltd. with experience in shaft sinking, recovering burning sulphide ore, grouting waste-rock backfill, and mining in collapsing pillars of ore. His experience also includes responsibilities for the daily underground activities of a 10,000 ton per day mining operation. These responsibilities covered all supervisory aspects such as training, safety, scheduling, costs and performance standards.

Since 1979, Bob has been involved with both consulting and contracting projects. The consulting projects have included feasibility studies and engineering design for new and existing mining properties. Bob has also participated in evaluation of projects dependant on innovative approaches such as hydraulic transportation of crushed ore and the underground recovery of bitumen from tar sands. The contracting projects have included preparation of bids and active on-site involvement in shaft sinking and shaft grouting programs. The most significant grouting program was the reduction of a 35 litre per second water intersection flowing into a shaft at 5200 kilo Pascals.

He is a registered Professional Engineer in Ontario and is a member of the Canadian Institute of Mining and Metallurgy.

SUPPLY AND SERVICES CANADA

ARTHUR W. MALKIN, P. Eng.
Chief Mechanical Engineer

Arthur W. Malkin received his Bachelor of Science degree with honours in Mechanical Engineering in 1965 from the University of Strathclyde, Glasgow, Scotland. He is a Registered Professional Engineer in the Province of Ontario, a Chartered Engineer, a member of the Institute of Mechanical Engineers in Great Britain, and a member of the Canadian Institute of Mining and Metallurgy.

After initial training in production coal mines, Mr. Malkin held various engineering positions with the National Coal Board in the U.K., finally joining the N.C.B. Research and Development Department in London, England.

He moved to Canada in 1966 as Plant Engineer at Duval Potash Mine during shaft sinking and progressed to Western Division Plant Engineer located in Tucson, Arizona. He was appointed Chief Plant Engineer for Cementation Canada/America Ltd. in Toronto and held that position until 1974.

Transferred to the U.K. he was engaged as Senior Design and Development Engineer on the Selby New Mine Complex in England.

Mr. Malkin joined Canadian Mine Services in 1979 as Chief Mechanical Engineer and is responsible for mechanical design and the mechanical, electrical and civil support construction section of the CM Group.

During his period with the CM Group he has been involved in conveyor, crusher and hoist installations, structural design and detail for mine services. Recent projects include the design of an internal shaft for the Granduc Project and the underground mill construction for Scottie Gold Mines Ltd. Current projects include the mechanical and structural design of the Underground Research Laboratory for Atomic Energy of Canada Limited.

SUPPLY AND SERVICES CANADA

ALLYN J. STEWARD, P. Eng.
Chief Mining Engineer
Western Canada Operations

Allyn Steward graduated from the University of Saskatchewan with a Bachelor of Science in Mining Engineering in 1967. Following graduation he was employed by Sherritt Gordon Mines Limited and remained there until 1970. He was employed in various capacities in the mine engineering department and underground supervision at Sherritt's Fox and Lynn Lake Mines.

In 1970 he joined McIntyre Porcupine Mines Ltd., and was employed in the mine engineering department, specifically dealing with gold operations.

Between 1971 and 1980 Mr. Steward was employed by Western Mines Ltd., initially as Chief Engineer, a position he held for five years and subsequently as Mine Superintendent for three years. In 1980 he held the position of Manager for the Western Mines operation in the Pine Point area.

Mr. Steward has been with Canadian Mine Services since 1980 and has been responsible for providing engineering services to the Western Operations of the CM Group and for consulting assignments for Western Canadian clients in the mining and construction industries.

He has been involved in cost estimating and engineering design for major tunnel projects including railway tunnels serving the North Eastern British Columbia coal deposits.

Mr. Steward has also directed mine feasibility studies including methods selection and operating and capital cost estimates and was project leader for a structural design assignment for the Scottie Gold Mines Limited crusher installation and cyanide mill.

SUPPLY AND SERVICES CANADA

HERMAN F. HOFFMAN, C.E.T.
Senior Engineering Technician

H.F. Hoffman graduated from the Mining Technician Institute in Newmark, Germany in 1944 with a Mining Technician Engineering degree.

Upon graduation, he joined the Armed Services where he remained until his departure to Canada in 1952.

In Canada, Mr. Hoffman has worked with various mining companies: as a Miner, Surveyor, Chief Surveyor, Captain, Chief Engineer and Assistant Project Engineer. Included are 11 years with MacIsaac Mining & Tunneling Co. Ltd. in Sudbury, Ontario. For one year under MacIsaac, Herman served as a Technical Adviser at the Training Center of Hindustan Copper Limited in India.

Fields of special competence include mine feasibility studies relating to underground mining development and shaft sinking, layouts and drafting of complete shaft sinking equipment, drift and raise layouts and the complete planning of mining orebodies by shrinkage and longhole methods.

For a period of 14 months beginning in 1977, Herman was employed as a Mining Inspector for the Ministry of Labour, Mining Health and Safety Branch, in Thunder Bay, Ontario.

In the fall of 1978 he joined Canadian Mine Services as Senior Engineering Technician in the Business Development Department. He has been involved in the bidding and cost evaluation of new jobs as well as participating in the preparation of numerous engineering studies.

Mr. Hoffman is a Registered Senior Engineering Technician with the Ontario Association of Certified Engineering Technicians and Technologists and is also affiliated with the Canadian Council of Engineering Technicians and Technologists.

SUPPLY AND SERVICES CANADA

E. WAYNE MARSHALL
Senior Engineering Technician

E. Wayne Marshall attended the B.A. program at the University of British Columbia. His education was furthered by completing engineering courses at a number of technical institutes.

His initial mining experience was gained from 1963-1967 as a summer student working in the Bridge River Mining area of British Columbia.

As Chief Surveyor for Bralorne-Pioneer Mines Ltd. he provided surveying services for all phases of underground development, production and exploration programs.

In 1967 he joined Bralorne Can-Fer Resources Ltd. and as Mine Technician was responsible for reserve estimates, ventilation studies, mine layouts and production planning. In addition he was involved with mineral property examinations at many sites throughout B.C.

With Canadian Mine Services since 1970, he has an extensive background in the research and development of mining equipment, contract bidding, feasibility studies, internal company assignments and both conceptual and detailed mine design. Responsibilities have included the development and implementation of engineering skills and practices within the engineering group. He has also been active in providing engineering assistance to major mining contracts located across Canada, the United States and in Ireland.

He is a member of the Canadian Institute of Mining and Metallurgy and a member of the Society of Mining Engineers of AIME.

SUPPLY AND SERVICES CANADA

GORD LUNDY, C.E.T.
Engineering Technician

Gord Lundy graduated from Ryerson Polytechnical Institute in Toronto with a Certified Engineering Technologist Diploma in 1976.

Following graduation, Gord joined S. McNally & Sons Ltd. in Hamilton as Purchasing Agent responsible for buying construction materials and equipment, as well as pricing tenders for bidding civil contracts.

Prior to joining Canadian Mine Services Ltd. in 1980, Gord was Estimator for the Mining and Ground Engineering Departments of Cementation. He was responsible for checking drawings, specifications, and contract documents, as well as quantity estimating and costing for the preparation of construction bids and engineering studies.

Since joining Canadian Mine Services Ltd., Gord has been responsible for cost estimates and scheduling for the preparation of feasibility studies for the development of new mining projects. His work has involved the use of a micro-computer in costing exercises, and he has also generated financial reports and cost analyses for use by management.

Recent projects include performance analysis, cost estimating and scheduling for the Underground Research Laboratory to be constructed by Atomic Energy of Canada Limited, activities which have been facilitated by computer-aided techniques.

6.0 RELEVANT EXPERIENCE

6.1 OVERVIEW

Canadian Mine Services Ltd. has over twenty years of underground hard-rock mine operating experience directly related to the subject areas which are the focus of this project. This background in the mine contracting field is particularly significant in ensuring that the engineering work done by our firm is of the highest calibre and has direct practical application to real mining situations. It is this close liaison between contracting operations and our consulting engineering activities which qualifies our firm for this project. Similarly, the fact that our firm maintains a research and development group, actively involved in the development and manufacture of mining machinery, provides a background ideally suited to this particular project which is not found in other consulting organizations.

Our firm has been particularly successful in attracting personnel with years of experience on mine operating staffs from mines across Canada and Overseas. The fact that the project team members proposed for this project have had responsible positions at operating mines, and continue to participate in on-going contracting projects ensures that the viewpoints held are both practical and realistic. In addition, contacts directly related to this project can be drawn from our current client list, as well as from those clients previously served by our contracting and engineering groups. Other organizations, such as the Mines Inspectorate, contractors, utilities and equipment manufacturers are found in our daily dealings with the mining industry across the country.

6.2 ENGINEERING EXPERIENCE

Since the inception of the company, Canadian Mine Services Ltd. has provided engineering services to the mining industry in terms of mine design, feasibility studies and mining methods evaluation. In recent years, the engineering department, from which the project team is drawn, has demonstrated competency in handling projects of conceptual and detailed mine designs, as well as in fields related to the analysis of current and potential mining

technologies. At the 1982 Prospectors and Developers Convention, held in Toronto, P. White contributed to a presentation assessing the future of the mining industry. A review was made of the mining equipment that would likely be operating in the year 2007 and the implications related to the mine design of a typical base metal ore deposit were outlined.

Canadian Mine Services Ltd. has been providing consulting engineering expertise to Atomic Energy of Canada Limited for the past 3 years in areas related to the disposal of nuclear waste in underground vaults. The scope of our involvement relies heavily on our experience in current mining technologies, and involves a detailed assessment of the future mining technologies and their relationships to the disposal of nuclear fuel waste. Numerous reports have been authored by members of the project team for AECL providing extensive documentation and analysis of hypothetical mining scenarios. The analysis of options and the selection of mining equipment has formed a key aspect of our consulting role for AECL. Based on the success of the conceptual projects completed for AECL, Canadian Mine Services Ltd. were assigned the task of designing an underground research laboratory, to be constructed near Lac du Bonnet, Manitoba commencing in 1983. This involvement by our firm in conceptual and detailed designs satisfying the stringent requirements of AECL demonstrates the competency of our firm, and the members of the project team, in work directly related to the subject of this proposal.

Additional work completed in the last two years includes a shaft and tunnel design assignment for GULF-AOSTRA for the Surmont Insitu Oil Sands Project in Alberta. The role of Canadian Mine Services Ltd., as consulting engineers, was to evaluate technical options for sinking shafts and driving tunnels in the oil sands of Alberta and to verify the economic feasibility of selected methods. Because of the unique requirements for mining in the oil sands using underground methods, the majority of this project focused on the development of new technologies to satisfy the objectives of the Surmont Project. The consulting work done for GULF-AOSTRA, similar to the work being undertaken currently for AECL, required extensive documentation, and numerous reports were written concerning the various aspects of shaft sinking

and tunnelling. Of interest to this study were methods for the blind boring of mine shafts and the development of hard-rock tunnelling machines.

Typical of many recent projects was work done for Amax Inc., on their Yorke-Hardy Project located near Smithers, British Columbia. For this project, Canadian Mine Services Ltd. were required to assess the mine design requirements utilizing current, as well as potential, mining technology to assess the impact of different mining scenarios on the overall profitability of the project. Several different mining methods were investigated, over a variety of production rates. Again, the results of this study were thoroughly documented in a series of volumes, reporting to the client in documented form, the recommendations and conclusions regarding the mining options for the ore reserves on that property.

In addition, the members of the project team for this study are frequently called upon to assess the technical and economic feasibility of various mining systems being examined by the research and development group of the company. The team members also participate in the assessment of mineral properties being investigated by Canadian Mine Services Ltd. to comment on the viability of potential mining operations.

Additional information on mining engineering assignments completed by our firm are contained in Appendix A of this proposal.

6.3 CONTRACTING AND CONSTRUCTION EXPERIENCE

Canadian Mine Services Ltd. was one of the first major mining organizations in Canada to convert to electric-hydraulic blasthole drilling for development mining operations. The use of this equipment is becoming more accepted in industry, and is in wide use throughout our company. As a result of the improved environment and enhanced safety of operation resulting from the use of electrical power underground, contracting forces within our company have made extensive use of electrification, to minimize the use of pneumatic and diesel operated equipment. The utilization of electrically operated equipment has made our working crews among the most productive in the country and has

resulted in the development of significant competitive advantages over mining techniques employed by other firms.

In the past two years, members of the project team have been responsible for designing several shaft hoisting installations, incorporating state of the art technology to accommodate the mandatory remote sensing and automation required of mine hoisting systems. In addition, company crews, working under the direction of A. Malkin, are responsible for the correct installation and commissioning of hoisting systems at mine plants across Canada. Currently Canadian Mine Services Ltd. is installing hoists in Goderich and Elliot Lake, Ontario. Other examples of field experience related to the subjects of this proposal include the construction and installation of an underground crushing and conveying complex for Denison Mines Limited in Elliot Lake, Ontario. This installation featured modern crushing and conveying equipment, including a very elaborate control and instrumentation system. The successful installation, commissioning and continuing operation of these installations demonstrates the ability of Canadian Mine Services Ltd., and the members of the project team, to bring relevant experience to the undertaking of this project.

Virtually every contracting job undertaken by the company has benefited from a review of the mine design requirements with the client and the modification of specific project requirements to accommodate improvements in the application of mining technology normally resulting in a substantial savings to the client. Specific examples include the involvement of members of the project team in the underground development of the Agnew Lake mining project near Espanola, Ontario, which implemented the latest developments in leaching technology for the extraction of underground uranium ore reserves. In addition, Canadian Mine Services Ltd. were instrumental in the mine design, equipment development and selection, and actual mining operations associated with mining of the upper uranium ore reef for Denison Mines Limited in Elliot Lake, Ontario. Prior to the work undertaken by our firm, under the direction of members of the project team proposed for this project, the mining of this upper reef ore zone had not been successfully demonstrated.

Information provided in Appendix A identifies additional areas where Canadian Mine Services Ltd. has significantly contributed to the development and refinement of mining technology and have successfully applied this practical experience to the benefit of many clients. We regard this experience as being essential in satisfactorily completing the requirements of this project.

6.4 RESEARCH AND DEVELOPMENT

Our research and development group is engaged in the development of new machinery and equipment which is designed to increase productivity and safety in mining operations.

The group is very much aware of the desirability of electrification of certain mining activities, and has already contributed to the increased dependence of Canadian Mine Services Ltd. on this power source. A further increase in the utilization of electric power in mining systems and related new machinery is currently in the planning stages. The research and development group is also deeply involved in the evolution of continuous ore loading and transportation systems and machinery. Design tasks are frequently oriented towards the mechanization and automation of mining activities. Remote control and monitoring capability has been incorporated into machines on more than one occasion. The potential for the application of recently evolved technology to the mining industry is recognized by the research and development group as an area where a significant contribution can be made by our organization.

The research and development group is currently working on an advanced high-speed mining system, the details of which have been disclosed to and approved by Industry, Trade and Commerce under the Enterprise Development Program. Studies carried out in assessment of this high-speed mining system will be of considerable value to the subject requirements of this study.

As an indication of the personnel resources within the research and development group to be made available for the purposes of this study, it is of interest that a member of the research and development group is currently serving as a member of the Canadian Standards Association Technical

Committee on Underground Diesel Equipment. This committee is charged with formalizing national standards for the application of diesel powered underground mining machinery. First-hand knowledge of this activity and an appreciation of its impact on the mining industry will also be of value to the subject requirements.

In addition to in-house research and development work, Canadian Mine Services Ltd. maintains communication with other groups involved in similar activities. As a result of this involvement with other groups, our firm has access to information regarding potential developments in equipment technology which, for a variety of reasons, are not normally known to the industry at large. Specifically, one of the major manufacturers of underground mining machinery will soon be unveiling a revolutionary breakthrough in the area of mechanized mine development. This technology will be publicly announced in January 1983 and the initial production of machinery for use by the industry will be available during the summer of 1983.

With this background, it is clear that Canadian Mine Services Ltd. are well positioned to undertake and to contribute to the various subject areas outlined in the requirements for this project.

7.0 PROPRIETARY INFORMATION

Canadian Mine Services Ltd. will make full use of internal documents, reports, libraries and personnel experience in the undertaking of this project. None of the information to be included in the project reports will be of a proprietary nature.

SUPPLY AND SERVICES CANADA

8.0 PRICE PROPOSAL

Canadian Mine Services Ltd. propose to undertake, prepare and deliver reports, prepared in accordance with good engineering practices, to satisfy the requirements of this project for the total firm price of **Eighty Three Thousand, Two Hundred and Fifty Dollars ($83,250.00)**.

The planned cost of work by month and by task is shown on the contract plan and report form, included as part of the management proposal, Section 9.0 of this proposal.

Detailed cost breakdown by task description is included as Table 8.1. The labour costs include the hours to be worked when calculated at the rates shown on Table 8.2. Reproduction expenses are estimated for the preparation of major documents. Reproduction expenses for routine project documents are included as part of the labour overhead and are not costed directly to the project. Air travel expenses are estimated at cost for the travel itinerary previously outlined in Table 3.7. The expenses for ground transportation, accommodation and meals are estimated at cost.

Miscellaneous items such as postage, telephone and telex charges form part of labour overheads and are not costed directly to the project.

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MAS SECRETAIRE

Table 8.1 **Detailed Cost Breakdown by Task Description**

	Event Sequence	Mandays	Labour	Reproduction Expenses	Air Travel	Ground Transport Hours	Total Project Costs
1.	Initial meeting with Scientific Authority to confirm project objectives and to establish direction of work	2	560		440	100	1 100
2.	Review previous work, prepare questionnaire	40	11 200	300			11 500
3.	Review meeting with Scientific Authority to confirm questionnaire and procedure	2	560		440	100	1 100
4.	Site visits with mines, manufacturers, inspectorate, contractors, utilities	50	14 000		3 300	5 250	22 550
5.	Review meeting with Scientific Authority following site visits	2	560		440	100	1 100
6.	Prepare draft report on mine electrification	30	8 400	100			8 500
7.	Prepare draft report on high capacity ore handling	30	8 400	100			8 500
8.	Prepare draft report on equipment automation	15	4 200	100			4 300
9.	Prepare draft report on high speed development	15	4 200	100			4 300

DSS SECRETARY

Table 8.1 **Detailed Cost Breakdown by Task Description**/Continued

	Event Sequence	Mandays	Labour	Reproduction Expenses	Air Travel	Ground Transport Hours	Total Project Costs
10.	Prepare draft report on remote control systems	15	4 200	100			4 300
11.	Prepare draft report on retaining waste rock	15	4 200	100			4 300
12.	Prepare draft summary report	15	4 200	100			4 300
13.	Review draft reports with Scientific Authority	2	560		440	100	1 100
14.	Prepare and issue final reports	15	4 200	1 000			5 200
15.	Review final reports with Scientific Authority	2	560		440	100	1 100
		250	70 000	2 000	5 500	5 750	83 250

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MAC SECRETARIAT

SUPPLY AND SERVICES CANADA

Table 8.2 **Schedule of Labour Rates**

Position	Hourly Rate	Staff Personnel
Principal	$ 55	J. Tatak R. Crawshay
Chief Engineer	$ 40	P. White A. Steward A. Malkin
Engineer	$ 35	T. Mann R. Clarke
Technician	$ 30	H. Hoffman W. Marshall G. Lundy
Drafting	$ 20	M. Lum S. McGlade
Typist	$ 15	L. Hall J. Rose

DSS SECRETARY

9.0 MANAGEMENT PROPOSAL

The time schedule for the project is shown on the contract plan and report form on the following page, as is the cash flow by month and by task description.

The manpower loading will consist of one professional mining engineer working on a full time basis, with assistance from principals, chief engineers, other engineers, technicians, draftsmen and typists on an as required basis.

The project manager will be P. White, P.Eng., Chief Mining Engineer, who will supervise and direct all activities associated with this project. There will be no subcontracts associated with this project as all work will be undertaken by Canadian Mine Services Ltd. personnel.

The proposed time schedule is based on acceptance of this proposal in time to hold the initial meeting with the scientific authority early in January, leading into preparation of a suitable questionnaire and interviewing procedure to facilitate the solicitation and documentation of information received during the site visits. Following the actual site visits with selected mines, manufacturers, contractors and mines inspectorates, to be done during February, March and April, a series of draft reports will be prepared covering the various aspects of this project.

These reports will be issued in stages during June and July to enable review by the Scientific Authority to take place during June, July and August. Final reports will be issued in August, incorporating comments from the Scientific Authority.

Supply and Services Canada / Approvisionnements et Services Canada

DSS/MAS 0145-3 (4/81)

CONTRACT PLAN AND REPORT FORM – FORMULE DE PROJET DE CONTRAT ET DE RAPPORT

CONTRACT TITLE – TITRE DU CONTRAT: Identification of Underground Equipment Development Potential

CONTRACTOR – ENTREPRENEUR: Canadian Mine Services Ltd.

FILE NO. – N° DU DOSSIER: 26SQ.23440-2-9155

CONTRACT NO. – N° DU CONTRAT:

TASK DESCRIPTION / DESCRIPTION DE LA TÂCHE	TASK DURATION IN MONTHS – DURÉE DE LA TÂCHE EN MOIS												TASK COST – COÛT DE LA TÂCHE		
	1 Jan.	2 Feb.	3 Mar.	4 Apr.	5 May	6 June	7 July	8 Aug.	9	10	11	12	PLANNED / PRÉVU À L'ORIGINE	ACTUAL / RÉEL	E.T.C. / À VENIR
Initial Meeting With Scientific Authority	▼												1,100		
Review Previous Work Prepare Questionnaire	▬	▬											11,500		
Review Meeting With Scientific Authority		▼											1,100		
Site Visits		▬	▬	▬									22,550		
Review Meeting With Scientific Authority				▼									1,100		
Draft Report On Mine Electrification				▬	▬	▬							8,500		
Draft Report On High Capacity Ore Handling					▬	▬							8,500		
Draft Report On Equipment Automation						▬	▬						4,300		
Draft Report On High Speed Development							▬	▬					4,300		
Draft Report On Remote Contrul Systems							▬	▬					4,300		
Draft Report On Retaining Waste Rock							▬	▬					4,300		
Draft Summary Report								▼					4,300		
Review Draft Reports With Scientific Authority								▬					1,100		
Issue Final Reports									▼				5,200		
Review Final Reports With Scientific Authority													1,100		
PLANNED COST OF WORK THAT WERE TO HAVE BEEN DONE / COÛT PRÉVU POUR TRAVAUX PRÉVUS	10,600	10,600	10,000	10,450	12,300	12,200	10,800	6,300					83,250		
ACT. ACCUM.	E.T.C. OF WORKS REMAINING TO BE DONE / À VENIR POUR TRAVAUX RESTANTS													ACTUAL COSTS TO DATE / COÛTS RÉELS À CE JOUR	E.T.C. / À VENIR

SUPPLY AND SERVICES CANADA

APPENDIX A

COMPANY QUALIFICATIONS

CANADIAN MINE SERVICES LTD.

COMPANY QUALIFICATIONS

DECEMBER 1982

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COMPANY BROCHURE

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EQUIPMENT DESIGN AND MANUFACTURE

PAPERS

THE CM GROUP

ENGINEERS
CONTRACTORS
DRILLERS
SERVING THE MINING INDUSTRY.

The CM Group

CANADIAN MINE SERVICES LTD.

CANADIAN BASED SUBSIDIARIES:
CANADIAN MINE ENTERPRISES LTD.
CAMERON McCUTCHEON DRILLING LIMITED
GOLD RIVER CONSTRUCTION LTD.
HASTE MINE DEVELOPMENT LTD.
CAMERON McMYNN CONTRACTING LTD.
SPHERE EQUIPMENT & SUPPLY LTD.

AMERICAN BASED SUBSIDIARIES:
CM, INC
AMERICAN MINE SERVICES,INC.
A.M.S., INC.
U.G.X., INC
CM GROUP, INC.

ASSOCIATED COMPANIES:
DAWSON CONSTRUCTION LIMITED
(AND ITS SUBSIDIARIES)

BOARD OF DIRECTORS

G. R. Dawson, P.Eng., Chairman
A. D. McCutcheon, P.Eng.
L. R. Norton, B.A.
G. Vooro
A. J. McDougall, P.Eng.
B. L. Blain
W. B. Laurie, C.A.
J. A. Capstick

CANADIAN MINE SERVICES LTD.

G. R. Dawson, P.Eng.
Chairman of the Board

A. D. McCutcheon, P.Eng.
President

L. R. Norton, B.A.
Executive Vice-President
and Secretary

J. C. Folinsbee, P.Eng.
Senior Vice-President —
Engineering

C. D. MacDonald, P.Eng.
Senior Vice-President —
Drilling

R. Crawshay
Senior Vice-President —
Technical Services

K. A. Hawrelak, B.Comm., C.A.
Vice-President — Finance
Assistant Secretary

CANADIAN MINE ENTERPRISES LTD.
Canadian Based Subsidiaries

G. Vooro
President

K.A. Hawrelak, B.Comm., C.A.
Vice-President
Finance & Secretary

J. I. Tatak, P.Eng.
Vice-President —
Engineering

E. Eliev
Vice-President —
Mining

A. W. Beck, B.Comm., C.A.
Assistant Secretary &
Controller — Western Operations

L. A. St. Louis, M.B.A.
Controller —
Eastern Operations

CM, INC/AMERICAN MINE SERVICES INC.
American Based Subsidiaries

A. J. McDougall, P.Eng.
President

L. R. Norton, B.A.
Vice-President &
Secretary

K. A. Hawrelak, B.Comm., C.A.
Vice-president — Treasurer
and Assistant Secretary

J. R. Lamb, B.A.
Controller and
Assistant Secretary

INTRODUCTION

Historically the mining contractor has provided service to mining companies to execute initial exploration and development programs, or to supplement in-house capacity in periods of peak activity.

More recently, with the ever increasing complexity of technology, and rapid advance of mechanization into widespread areas and with the attendant problems of providing the necessary specialized equipment and personnel, the contractor's role has been extended to other functions. This now includes the development not only of specialized mining techniques, but also the integration of equipment design and construction with specific operational requirements.

The historical function still constitutes the prime reason for the contractor's existence. However, a progressively more technical involvement is resulting in a broader contract base of integrated activities with the resulting benefits of stability, improved application, and efficiency.

Abstract of a paper presented by A. D. McCutcheon, President, Canadian Mine Services Ltd., at the 78th Annual General Meeting, CIM; Quebec, Que., April 28th, 1976.

SCOPE OF SERVICES

The CM Group offers a comprehensive range of services related to surface and underground mining.

MINING ENGINEERING & MANAGEMENT

- Project Management — underground development, construction and production.
- Mine Planning and Design — underground and surface.
  - — mining plant
  - — development and extraction
  - — mining methods and layouts
- Efficiency and economic analysis of mining operations.
- Mining equipment analysis and selection.

CONTRACT MINING

- Mine plant construction and erection.
- Mine exploration and development.
  - — shaft sinking
  - — tunneling (track and trackless)
  - — raising
  - — mine production

CONSTRUCTION

- Rock and earth excavation for the construction industry.
- Construction of tunnels for railroads, pipelines, and highways.
- Excavation and foundation work.

DRILLING

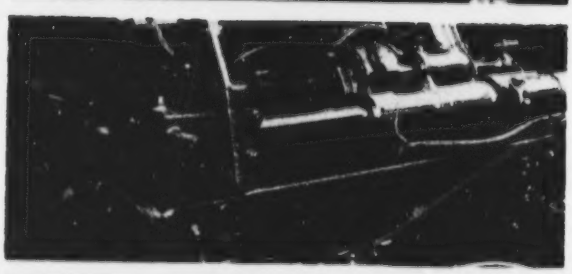
- Contract core drilling — surface and underground.
- Geotechnical sampling.
- Specialized percussion drilling.
  - — sampling and drainage
  - — production
- Management and consulting services.
  - — drill system development
  - — project management

RESEARCH, DEVELOPMENT & MANUFACTURING

- Custom underground mining equipment.
- Custom underground diamond drilling equipment.

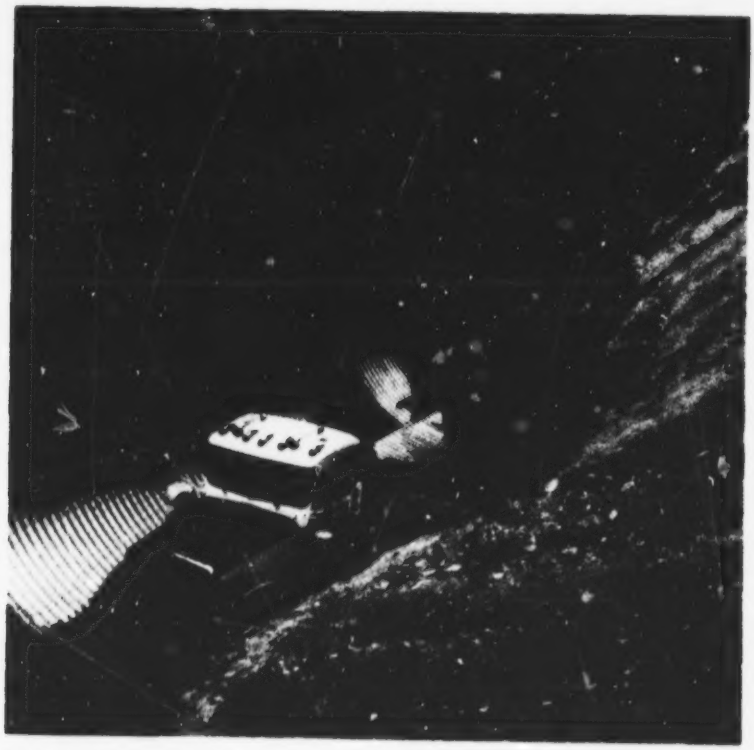
TRAINING

- Comprehensive training course development and application for:
  - — mining
  - — maintenance
  - — underground supervision



CLIENT ACCOUNT

Representative Clients:
(Period 1963-1980)



The following, although not a complete list, is representative of the clients we have served:

Afton Mines Ltd.
Agnew Lake Mines Ltd.
Alwin Mining Co.
Amax Exploration Inc.
American Borate Company
Amok Ltd.
Asarco Incorporated
Asbestos Corp.
Brenda Mines Ltd.
Brenmac Mines Ltd.
B.C. Department of Highways
B.C. Hydro & Power Authority
B.C. Railway
Canada Cement Lafarge Ltd.
Canada Tungsten Mining Corp. Ltd.
Canada Wide Mines Limited
Canadian Natural Resources Limited
Casino Mines Ltd.
Cities Service Co.
Climax Molybdenum Corporation
Cominco Ltd.
Cyprus Anvil Mining Corp.
Denison Mines Limited
Echo Bay Mines Ltd.
Eldorado Nuclear Ltd.
Endako Mines Ltd.
Falconbridge Nickel Mines Ltd.
Golder, Brawner & Associates
Granby Mining Corp.
Granduc Operating Co.
Gulf Canada Resources Inc.
H.A. Simons Ltd.
Hecla Mining Co.
Homestake Mining Co.
Hudson Bay Mining & Smelting Co. Ltd.
Imperial Oil Ltd.
Inland Cement
Kennecott Copper Corp.
Kerr Addison Mines Limited
Mattabi Mines Ltd.
Mogul of Ireland Ltd.
Newfoundland Zinc Mines Ltd.
Newmont Mining Corp.
Noranda Mines Ltd.
Northair Mines Ltd.
Occidental Minerals Corporation
Park City Ventures
Pechiney (Canada) Ltd.
Phelps Dodge Corp.
Prem Resources Ltd.
Pyramid Mining Corp.
Rio Blanco Oil Shale Project
Sezco Mining Corporation Limited
Tara Mines Ltd.
Teck Corporation Limited
Terra Mining & Exploration ltd.
The Anaconda Company
Union Carbide Canada Ltd.
United Nuclear — Homestake Partners
United States Steel Corp.
Utah Construction & Mining Co.
Westrob Mines Ltd.
White Pass & Yukon Railway

A.D. McCUTCHEON, P.ENG.,
President — Canadian Mine Services Ltd.

Since graduating from the University of Alberta in 1949 with a B.Sc. degree in Mining Engineering, Archie McCutcheon has been employed continuously in the mining industry, in various operating, engineering and management capacities at mining properties throughout Canada, and since 1964 has been an officer of Canadian Mine Services Ltd.

He is a member of the Canadian Institute of Mining and Metallurgy, the American Institute of Mining Engineers, the Engineering Institute of Canada, and the Association of Professional Engineers of British Columbia.

L.R. NORTON, B.A.
Executive Vice-President and Secretary
Canadian Mine Services Ltd.

L. R. "Dick" Norton graduated from the University of Washington in 1953 and continued his studies in the Graduate School of Business Administration until mid 1955.

Then followed twelve years with the Anaconda Company in South America, Ontario and British Columbia, before joining Canadian Mine Services in 1966 where he is responsible for Financial and Corporate Affairs. He is a member of the Canadian Institute of Mining and Metallurgy and the American Institute of Mining, Metallurgical, and Petroleum Engineers.

GEORGE VOORO,
President — Canadian Mine Enterprises Ltd.

George Vooro's vast expertise in the mining industry has been acquired through his personal involvement in many underground track and trackless operations since 1946. His past experience includes years as a practical miner using a wide variety of methods and equipment, and as a supervisor, from shiftboss through all levels of responsibility.

Mr. Vooro has been associated with Canadian Mine Services Ltd. since 1963 and is responsible for operations in Canada. He is a member of the Canadian Institute of Mining and Metallurgy.

ANGUS J. McDOUGALL, P.ENG.,
President — CM, Inc/American Mine Services, Inc.

Angus J. McDougall received a Bachelor of Applied Science degree in Mining Engineering in 1950, from the University of British Columbia. He has held various supervisory, engineering and management positions in underground and open pit mines throughout Canada.

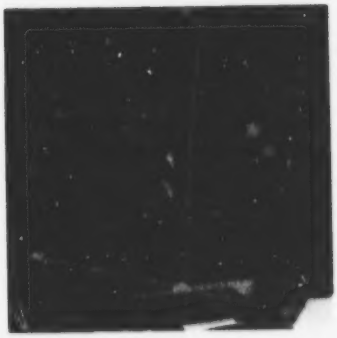
Mr. McDougall joined Canadian Mine Services Ltd. in 1968 and is currently responsible for operations in the United States and other locations outside of Canada. He is a registered professional engineer in the Province of British Columbia, a member of the Canadian Institute of Mining and Metallurgy, and the American Institute of Mining Engineers.

JOHN C. FOLINSBEE, P.ENG.
Senior Vice-President, Engineering — Canadian Mine Services Ltd.

John C. Folinsbee, a registered professional engineer in the Province of British Columbia and Manitoba, and the State of Nevada, is a 1951 graduate of the University of Toronto in Mining Geology.

His many years of experience in underground and open pit mining operations include supervisory, engineering, and management positions, and the preparation of mine feasibility studies.

Since joining Canadian Mine Services in 1976, Mr. Folinsbee has been responsible for Engineering Development and Western Canadian Operations.



C.D. MacDONALD, P.ENG.,
Senior Vice-President, Drilling — Canadian Mine Services Ltd.

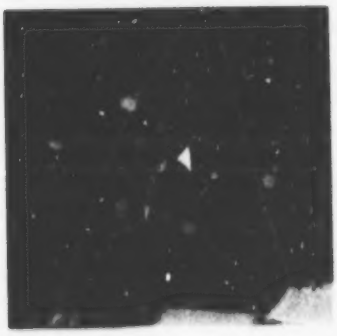
C. D. "Bud" MacDonald, a 1964 graduate of the Nova Scotia Technical College, has Bachelor and Masters degrees in Civil Engineering. Prior to joining Canadian Mine Services Ltd. in 1969, he held positions in test installations and materials engineering with the Federal Government, and was Branch Manager for an Eastern Canadian consulting firm.

He is a member of the Association of Professional Engineers of British Columbia, the Canadian Institute of Mining and Metallurgy, and of numerous U.S. Mining Associations.

RICHARD CRAWSHAY,
Senior Vice-President, Technical Services
Canadian Mine Services Ltd.

Richard Crawshay has twenty-six years experience in the design and manufacture of machinery coupled with first-hand knowledge of the operation and maintenance of a wide range of mining equipment.

He joined the Company in 1972 to establish a research and development team. Since then he has contributed to the development of our Superdrill diamond drill, an in-line-loader, trackless haulage and support vehicles, and shaft sinking equipment. He has emphasized the development of machines designed to meet the special needs of modern mining and exploration methods.



K.A. HAWRELAK, B.COMM., C.A.,
Vice-President — Finance — Canadian Mine Services Ltd.

Kenneth A. Hawrelak graduated from the University of Alberta in 1970 with a Bachelor of Commerce degree. He articled with an international firm of Chartered Accountants in Toronto, Ontario, and obtained his C.A. from the Institute of Chartered Accountants of Ontario in 1975. He was admitted as as associate member of the Institute of Chartered Accountants of British Columbia in 1976.

Mr. Hawrelak joined Canadian Mine Services Ltd. in 1976 and was appointed Treasurer and Assistant Secretary of the Company in 1977.

MINING ENGINEERING and MANAGEMENT

CM offers a comprehensive range of mining engineering services, which include mine design, feasibility studies, economic analysis and development of mining methods.

Professional engineers and managers with diversified experience in modern mining technology respond effectively to challenging engineering assignments. In order to produce the best results, the engineering group works in close liaison with clients, colleagues in other disciplines, or entirely in-house.

Offices are located in Toronto, Denver, Vancouver and at various job sites.

Typical Recent Engineering Projects:

- Open pit feasibility and design.
- Underground development and extraction design and layout.
- Underground commodity storage design and layout.
- Major tunnel (30 KM) layout, excavation method, detailed cost analysis.
- Ground water control study and proposal relative to major shaft sinking project.
- Underground bulk sampling project. Detailed plan and design.
- Underground coal mine layout and design for extraction from steeply dipping seam.
- Mine development program. Detailed design, layout, schedules and economic analysis for shaft deepening, ramp excavation, stope access and ore handling facilities.

MINING

High performance and modern mining techniques in diverse ground conditions permit the CM group to undertake the most challenging jobs anywhere in the world.

Using conventional and sophisticated mining procedures, CM has successfully completed many thousands of feet of drifting, raising, shaft sinking and related excavations.

In addition to development work, the CM group's experience extends to production mining projects which include a full range of underground stoping methods, and open pit mining.

In many jobs complete site facilities are constructed. Some examples are construction of headframes, bunkhouses and shops and installation of hoists, power plants and compressed air plants.

On-site maintenance shops, staffed by skilled personnel, provide preventive maintenance programs for all operations. Purchasing and accounting are integral elements of each undertaking.

A variety of contract forms, including firm price, cost plus, target price and other more flexible arrangements demonstrate CM's adaptability.

Excavating rock with load-haul-dump unit.

Transporting material.

Drill jumbo at work underground.

Mechanized roof bolting.

Representative Projects

Completed or current:

AMAX EXPLORATION INC.
Yukon Territory

The development of 2,500′ of 8′ x 9′ trackless headings, test stope, and bulk sampling.

HOMESTAKE MINING COMPANY
Lead, South Dakota

Development of two internal shafts, 2,000′ of access decline and development of track and trackless headings in the old mine.

GRANDUC OPERATING COMPANY
Stewart, British Columbia

The development of a primary ramp system, approximately 25,000′ of 16′ x 16′ ramps per year @ 17% grades.

IMPERIAL OIL LIMITED
Gays River, Nova Scotia

Dewatering portal area, collar decline drive and the development of 2,000′ of exploration decline at a grade of 10%.

CANADA TUNGSTEN MINING CORP. LTD.
Tungsten, Northwest Territories

Underground mine and production development, including main haulage way, ventilation route, conveyor ways and production levels totaling 20,000 feet.

KERR ADDISON MINES LIMITED
Faro, Yukon Territory

Engineering, development and diamond drilling. 8,500′ of a 14′ x 14′ drift driven on a negative gradient of 16%. Surface and underground core drilling total 144,000 feet.

MATTABI MINES LTD.
Ignace, Ontario

The development of 3,000′ of main service decline at −20% grade.

NEWFOUNDLAND ZINC MINES LTD.
Daniel's Harbour, Newfoundland

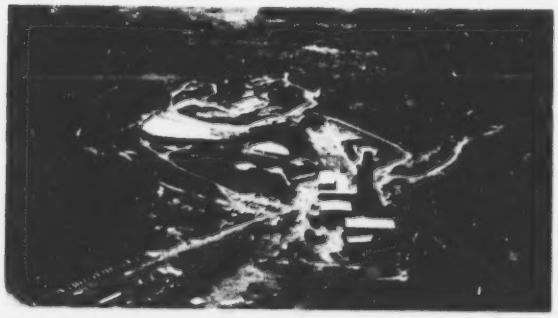
The development of a main access decline heading at −10% grade and associated mine development workings totaling over 10,000′.

TARA MINES LIMITED
Near Navan, County Meath, Ireland

The total development of a new underground mine near Navan, Ireland, which also included training of all the work forces for the owners. Completed 1,250′, 3 compartment timber shaft; 1,300′, circular cement lined 16′ diameter shaft; 25,000′ of trackless headings, 12′ x 18′ declines, haulage-ways, conveyor-ways; crusher station; sumps; 4,000′ Alimak raises. Trained 150 trackless miners, 50 mechanics, hoistmen, service crews and first line supervisors.

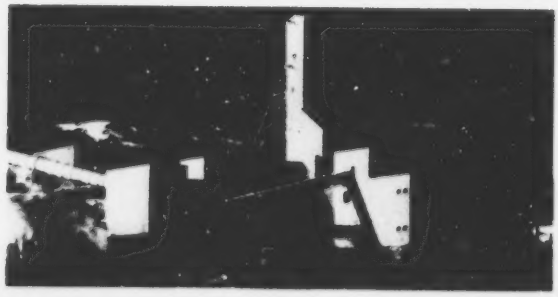
UNITED NUCLEAR-HOMESTAKE PARTNERS
Grants, New Mexico

The sinking of 620′ of shaft from surface and equipping the shaft for production. The driving of 3,000′ of underground development.



AGNEW LAKE MINES LTD.
Agnew Lake, Ontario

Total underground development for an in-situ leach mining method plus mine production level and ramp development totaling over 50,000′.



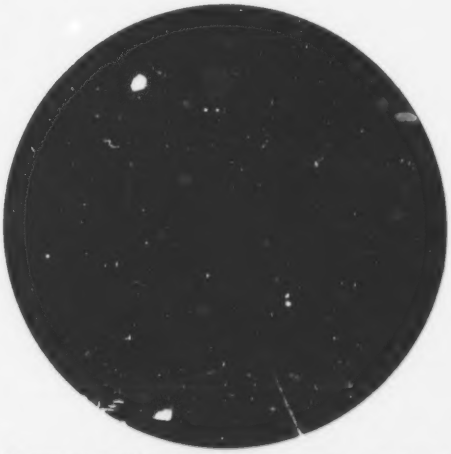
DENISON MINES LIMITED
Elliot Lake, Ontario

The development of 22′ x 25′ access headings, strike headings, production mining, engineering and feasibility studies.

CONSTRUCTION

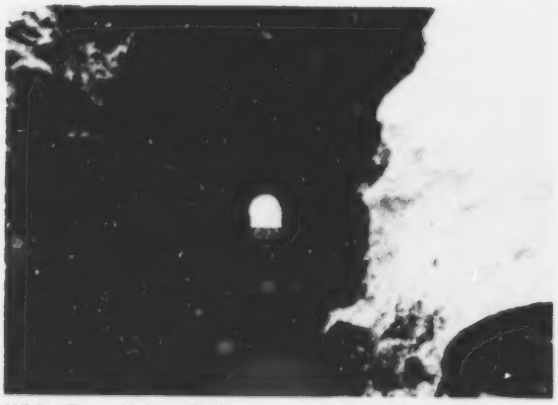
TUNNELING

CM has specialized experience in the excavation of tunnels and related work for the heavy construction industry. Major projects include tunnels for railroad, pipeline, effluent disposal and hydro access-outlet works tunnels.



CM jumbo used in the 34 foot diameter outlet works tunnel for B.C. Hydro at Mica Dam, B.C.

5,600 foot diversion tunnel north of Stewart, B.C.



White Pass Yukon Railroad tunnel Skagway, Alaska.

CONSTRUCTION

Projects include construction of primary access and haul roads, excavation and foundation work for mine townsite construction, and mining plants.

Road construction for Newmont Mining Corp., Kendrick Bay, Alaska.

DRILLING

The CM Group performs a complete range of drilling services for the mining and construction industries. By combining sound engineering principles with modern equipment and skilled operators, CM accomplishes the most difficult drilling projects.

Surface Core Drilling

CM executes both short exploration programs and large definition projects. Crews are skilled in mud application technology. Experience includes coring fractured permafrost formations and the use of air-foam flush systems. CM is also experienced in helicopter support programs and related camp construction. Unitized machines equipped for angle hole drilling are mounted on skids, trucks, or customized track laying vehicles.

Underground Core Drilling

CM is a unique drilling organization which has developed a family of hydraulic diamond drills known as "Superdrills". Superdrills are modular units that can be equipped for either track or trackless operations. World productivity records, have been established recently.

Specialty Services

CM provides consulting services to companies having in-house core drilling operations. This includes the introduction of modern equipment and technology, and training of operating personnel. CM also provides geotechnical sampling services to the mining and construction industries. Other specialized services include in-the-hole drilling, chip sampling and customizing of equipment for unique projects.

Unitized track drill.

Crawler mounted, diesel-hydraulic Superdrill.

Rail electric-hydraulic Superdrill.

Skid mounted electric-hydraulic Superdrill.

Representative Programs

The following briefly defines representative surface and underground core drilling programs.

SURFACE CORE DRILLING

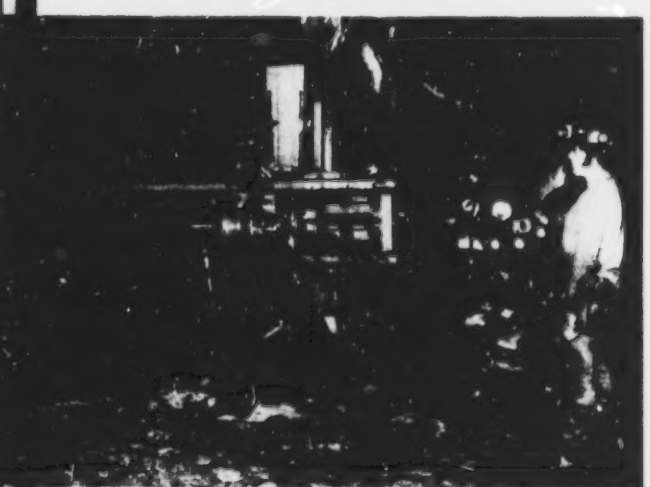
AMAX EXPLORATION INC.
Project — Kirwin
Location — Wyoming
Completed a major definition program at elevations to 13,000 feet, with boreholes to 3,000 feet in depth.

AMAX EXPLORATION INC.
Project — Mactung
Location — Yukon Territory
Drilled 33,000 feet in fractured permafrost formation, using specialized drilling fluids.

AMAX EXPLORATION INC.
Project — Minnamax
Location — Minnesota
Deep definition drilling.

HOMESTAKE MINING COMPANY
Project — Pitch Mine
Location — Gunnison, Colorado
Drilled soft sedimentary uranium deposit.

KERR ADDISON MINES LTD.
Project — Grum
Location — Yukon Territory
Drilled 82,800 feet with unitized, skid mounted drill units.



Electric, TD20 Superdrill on tractor.

UNDERGROUND CORE DRILLING

GRANDUC OPERATING COMPANY
Project — Granduc Mine
Location — Near Stewart, British Columbia
Drilled over 150,000 feet.

WESFROB MINES LTD.
Project — Underground exploration coring
Location — Tasu, British Columbia
Major up-hole program, averaging 84 feet per 8 hour shift from start of job to finish.

ANACONDA COMPANY, MONTANA MINING DIVISION
Project — Stewart and Leonard Mines
Location — Butte, Montana
Provided supervision, technical direction, and equipment for deep underground drilling through old stopes. NQ boreholes completed to over 2,400 feet in depth.

HECLA MINING COMPANY
Project — Lakeshore Mine
Location — Casa Grande, Arizona
Ring drilled from 11 foot arched drift. With 5 foot rods and corebarrels drilled 240 feet in one 8 hour shift.

HOMESTAKE MINING COMPANY
Project — Homestake Mine
Location — Lead, South Dakota
Provided consulting service to in-house drilling division.

KERR ADDISON MINES LIMITED
Project — Grum Joint Venture
Location — Near Faro, Yukon Territory
Drilled 62,000 feet of definition drilling at angles from vertical up to vertical down. Set world record of 6,488 feet in one machine month for BQ core underground.

AGNEW LAKE MINES LTD.
Project — Agnew Lake Mine
Location — Espanola, Ontario
Completed 40,000 feet of core drilling, in hard competent formations.

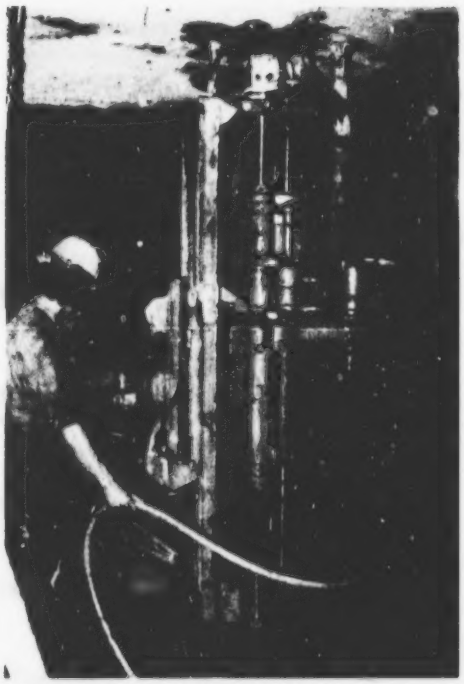
WHITE PINE COPPER COMPANY
Project — White Pine Mine
Location — White Pine, Michigan
Definition underground core drilling.

RESEARCH, DEVELOPMENT and MANUFACTURING

The CM Mechanical Development Division has designed and manufactured a wide variety of machines and equipment.

A broad range of design skills is combined with input from production oriented, innovative, operating and maintenance personnel to develop new, safe and more effective mining and diamond drilling machines and systems.

CM 1824, 24-ton capacity truck.

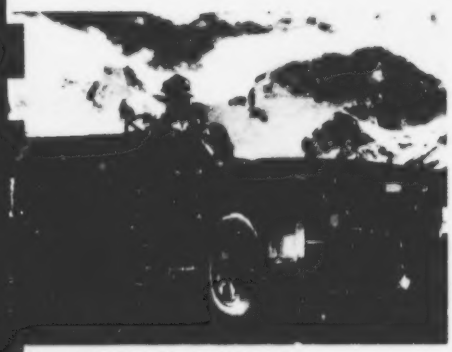


Rail electric-hydraulic Superdrill.

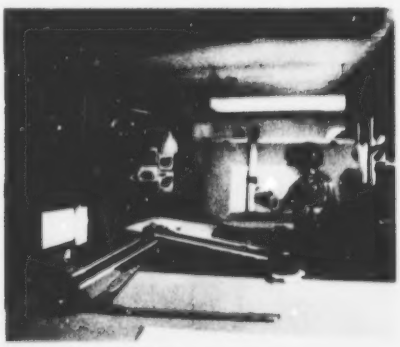
Low profile Hy-Grader.

Utility jumbo with scissor lift service platform.

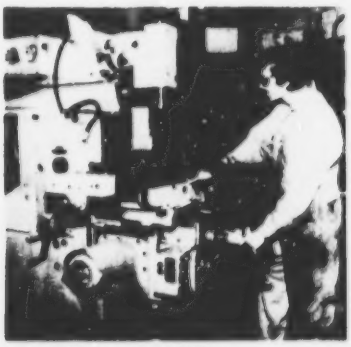
Electric-hydraulic rock drill jumbo.



King Nipper personnel carrier.

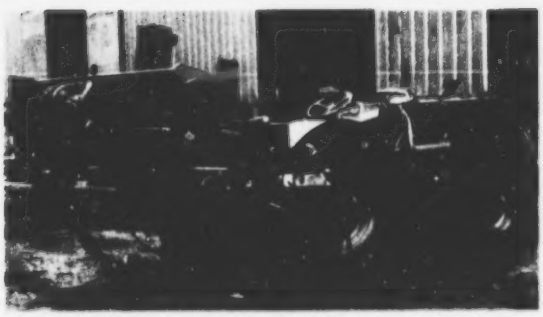


Equipment design.



Machining capabilities.

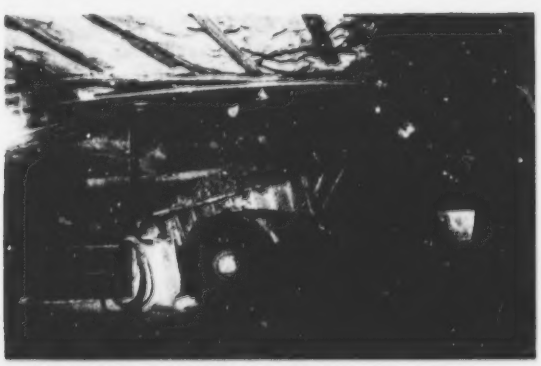
Unitized mobile diamond drill.



Electric-hydraulic mobile, short hole Superdrill TD20.

Roof bolting jumbo.

Mobile diesel-propelled, electric powered in-line loader.

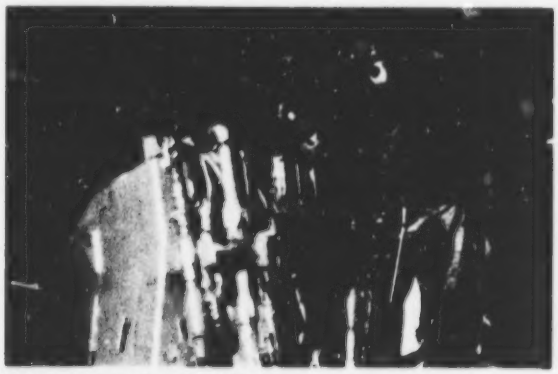


CM 3240, 40-ton capacity truck.

TRAINING

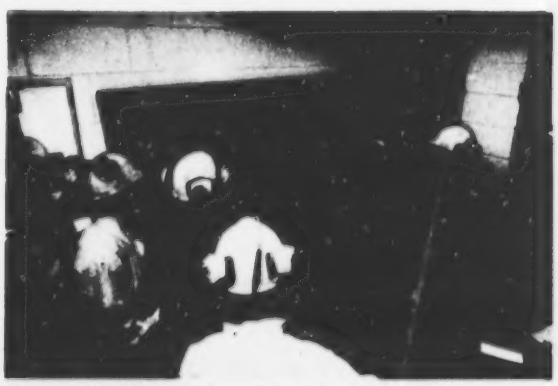
In conjunction with mine contracting, CM has developed a training program for all categories of underground personnel.

The training of miners consists of a program of classroom lectures, general orientation, and familiarization with, and operation of, mining equipment. On-site training is given by experienced mining instructors using a comprehensive training manual developed by CM.

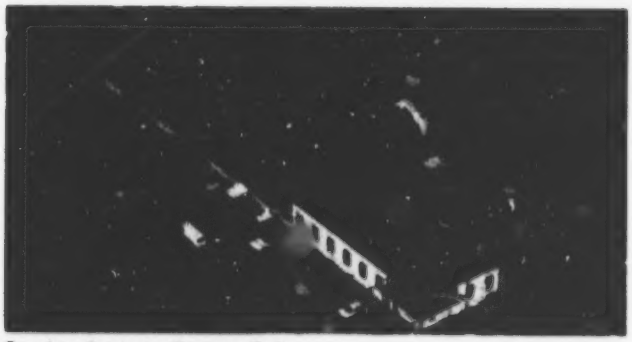


Trainee operating drill jumbo.

First aid training.



Electric blasting mock-up in classroom.



Service Center – Surrey, B.C.

Service Center – Elliot Lake, Ontario

Service Center – Denver, Colorado

EXECUTIVE OFFICES

CANADIAN MINE SERVICES LTD.
1595 Clark Boulevard
Brampton, Ontario L6T 4G1
Telephone — (416) 792-2700
Telex — 06-97762

CANADIAN MINE SERVICES LTD.
745 Clark Drive
Vancouver, B.C. V5L 3J3
Telephone — (604) 253-5251
Telex — 04-54311

CANADIAN MINE SERVICES LTD.
1, Calgary Place, Suite 403,
300 5th Avenue Southwest
Calgary, Alberta T2P 3C4
Telephone — (403) 266-2022

AMERICAN MINE SERVICE INC.
2705 Paris Street
Denver, Colorado
U.S.A. 80239
Telephone — (303) 371-9380
Telex — 0045-0217

CM, INC.
P.O. Box 1159
Kalispell, Montana
U.S.A 59901

SERVICE CENTERS

CANADIAN MINE SERVICES LTD.
1595 Clark Boulevard
Brampton, Ontario L6T 4G1
Telephone — (416) 792-2700
Telex — 06-97762

CANADIAN MINE SERVICES LTD.
8020-128th Street
Surrey, B.C. V3W 4E9
Telephone — (604) 596-7151
Telex — 04-351188

CANADIAN MINE ENTERPRISES LTD.
29 Perini Road, P.O. Box 220
Elliot Lake, Ontario P5A 2J7
Telephone — (705) 848-3635
Telex — 06-77314

AMERICAN MINE SERVICES INC.
5810 E. 77th Ave.
Commerce City, Colorado
U.S.A. 80022
Telephone — (303) 371-9380
Telex — 0045-0217

COMPANY HISTORY

The CM Group of companies began its growth in the Province of British Columbia in May of 1963.

Since then, the company has completed over 750 projects in Canada, the U.S. and Overseas.

The Group's capabilities have expanded from the original strengths of mining and drilling to include engineering services, project management, the development of machines and the training of skilled personnel.

Growth in the last five years is best seen by the annual volume of contract work:

1977	$32 million
1978	$48 million
1979	$47 million
1980	$74 million
1981	$95 million

COMPANY CAPABILITIES

OVERVIEW

. The principal business activities of the CM Group involve contract mining in the capacities of:

- Prime Contractor
- Sub Contractor
- Joint Venture

. Other business activities of the CM Group include:

- Mine and Mill Construction
- Engineering Services
- Project Managment
- Turn Key Projects
- Drilling
- Research, Development and Manufacture of Equipment
- Training

. The CM Group employs 600 people at locations across North America and Overseas.

. The CM Group employs 30 professional engineers and has an engineering staff of 75 people.

PROJECT MANAGEMENT

The CM Group accepts a wide variety of project management assignments including:

- turnkey development and construction
- turnkey production mining and milling
- prime contractor
- owner's representative for cost and quality control
- project management of diverse technical associates for large exploration and development projects

ENGINEERING SERVICES

Engineering services provided by the CM Group include:

Geological Engineering

- Ore Reserve Calculation
- Orebody Model Construction
- Bulk Sampling

Mining Engineering

- Technical and Economic Feasibility Studies
- Mine Design
- Mine Access and Development
- Ore and Waste Transportation Systems
- Mining and Stoping Methods
- Scheduling of Development and Production
- Detailed Cost Estimates
- Mine Services
- Special Studies

Mechanical- Electrical Engineering

- Hoisting Plants
- Support Services
- Ore Handling Systems
- Equipment Selection and Procurement
- Mill Design

Site Planning - Civil Engineering

- Access Roads
- Power Distribution
- Water Supply
- Shops and Offices
- Camp and Bunkhouses

CONTRACT MINING

The CM Group is involved in the following types of contract mining:

Mine Development

- Shaft Sinking
- Ramp Development
- Drifting, Track and Trackless
- Raise Development
- Mine Rehabilitation

Production Mining

- Underground Mining, Track and Trackless
- Pillar Recovery
- Bulk Sampling
- Mine and Mill Operation
- Open Pit Mining

Special Situations

- Dewatering
- Grouting
- Mining in Remote Areas

CONSTRUCTION

The CM Group accepts construction assignments for:

Excavation

- Construction of Tunnels for
  Railroads
  Pipelines
  Highways
- Excavations and Foundations Construction
- Cavern and Storage Bins Excavations

Major Installations

- Mine Site Preparation
- Headframe and Hoist Installations
- Crushing Station Installations
- Conveyor Installations
- Power Distribution Systems
- Shops and Offices
- Camps and Bunkhouses
- Mill Construction

DRILLING

The CM Group carries out a variety of drilling services:

- Contract Core Drilling- Surface
  - Underground
  - Helicopter Support
- Non-Coring Drilling Techniques - In-the-Hole Hammers
  - Top Drive Percussion
  - Rotary Drilling
- Geotechnical Sampling
- Consulting Service
- Complex Logistical Management
- Drill System Development

RESEARCH, DEVELOPMENT AND MANUFACTURE

The CM Group is active in the development and manufacture of a wide range of equipment:

- Jumbos - Tunnel - Electric Hydraulic
  - Diesel Hydraulic
  - Pneumatic
  - Shaft - Electric Hydraulic
  - Pneumatic
  - Rockbolting - Electric Hydraulic
  - Diesel Hydraulic
- Core Drills - Pneumatic
  - Diesel Hydraulic
  - Electric Hydraulic
- Haulage Trucks - 26 Ton
  - 40 Ton
- Service Vehicles - 2 Man Carrier
  - 16 Man Service
  - 16 Man Crew
- Custom Mining Equipment - Sinking Stages, etc.

TRAINING

The CM Group offers a comprehensive training program of personnel which is extremely valuable in regions without a history of mining.

Separate courses are available for the training of:

- Supervisors
- Miners
- Mechanics

The basic thrust of the training is on-the-job development of an effective, highly motivated and productive work force.

The full spectrum of mining is taught, including:

- industrial relations
- the nature of ore bodies
- underground mining conditions
- good health and safety practice
- skilled mining techniques
- correct use or maintenance of machinery
- motivation for effective co-operation and productivity

CORPORATE ORGANIZATION

Canadian Mine Services Ltd.

Canadian Based Subsidiaries:
- Canadian Mine Enterprises Ltd.
- Cameron McCutcheon Drilling Limited
- Gold River Construction Ltd.
- Haste Mine Development Ltd.
- Cameron McMynn Contracting Ltd.
- Sphere Equipment & Supply Ltd.
- Cambex Exploration Ltd.

American Based Subsidiaries
- C M, Inc.
- American Mine Services, Inc.
- A.M.S., Inc.
- U.G.X., Inc.
- C M Group, Inc.
- CNR Resources, Inc.

Associated Companies:
- Canadian Natural Resources Limited

Board of Directors - Canadian Mine Services Ltd.

G. R. Dawson, P.Eng., Chairman
A. D. McCutcheon, P.Eng.
L. R. Norton, B.A.
G. Vooro
A. J. McDougall, P.Eng.
R. A. Boulware
M. D. Rowswell, P.Eng.
J. G. Langille, C.A.

OFFICE LOCATIONS

Company Headquarters in Canada

Canadian Mine Services Ltd.
1595 Clark Boulevard
Brampton, Ontario
L6T 4C1

- Corporate Management
- Corporate Administration
- Project Management
- Engineering Services
- Procurement
- Equipment Manufacture
- Equipment Service Centre

Other Locations in Canada

Canadian Mine Services Ltd.
745 Clark Drive
Vancouver, British Columbia
V5L 3J3

- Regional Administration
- Project Management
- Project Engineering
- Engineering Services

Canadian Mine Services Ltd.
8020 - 128th Street
Surrey, British Columbia
V3W 4E9

- Procurement
- Equipment Manufacture
- Equipment Service Centre

Canadian Mine Enterprises Ltd.
29 Perini Road
Elliot Lake, Ontario
P5A 2T1

- Project Management
- Project Engineering
- Procurement
- Equipment Service Centre

Locations Outside of Canada

American Mine Services, Inc.
4705 Paris Street
Denver, Colorado 80239

- Executive Office for U.S.A.
- Administration
- Project Management
- Engineering Services
- Procurement
- Equipment Manufacture
- Equipment Service Centre

C M, Inc.
Kalispell, Montana

- Registered Head Office for U.S.A.

EXECUTIVE STAFF

Canadian Mine Services Ltd.

A. D. McCutcheon	President
L. R. Norton	Executive Vice President and Secretary
R. Crawshay	Senior Vice President - Technical Services
K. A. Hawrelak	Vice President - Finance
P. Cain	Vice President - Engineering and Mining Development

Canadian Mine Enterprises Ltd. and Canadian Based Subsidiary Companies

G. Vooro	President
C. D. MacDonald	Senior Vice President Western Canada Operations
J. I. Tatak	Senior Vice President Eastern Canada Operations
K. A. Hawrelak	Vice President - Finance and Secretary
E. Eliev	Vice President - Mining Eastern Canada Operations
F. W. Hales	Vice President - Mining Western Canada Operations
A. W. Beck	Assistant Secretary and Controller Western Canada Operations
L. St. Louis	Controller - Eastern Canada Operations

American Mine Services, Inc. and U.S. Based Subsidiary Companies

A. J. McDougall	President
J. C. Folinsbee	Executive Vice President
L. R. Norton	Vice President and Secretary
K. A. Hawrelak	Vice President, Treasurer and Assistant Secretary
W. H. Lane	Vice President - Engineering
D. Weddell	Vice President - Mining
J. R. Lamb	Controller and Assistant Secretary

A.D. (Archie) McCUTCHEON, P.Eng.
President
Canadian Mine Services Ltd.

Since graduating from the University of Alberta in 1949 with a degree in Mining Engineering, Archie has been employed in the mining industry in various operating, engineering, and management capacities at mining properties throughout Canada. Since 1964 he has been a principal of Canadian Mine Services Ltd.

He is a member of the Canadian Institute of Mining and Metallurgy, the American Institute of Mining Engineers, and the Association of Professional Engineers of British Columbia.

L.R. 'DICK' NORTON
Executive Vice President & Secretary
Canadian Mine Services Ltd.

L.R. 'Dick' Norton, orginally from Anaconda, Montana, served with the U.S. Navy during WW II, and was employed by the U.S. Government (A.T.S., MSTS) from 1948 to 1950.

Mr. Norton attended universities in Montana and Oregon before entering the University of Washington, where he graduated in 1953. He continued with graduate work in the University of Washington Graduate School of Business Administration until mid 1955, at which time he entered the mining and construction industries.

Prior to joining Canadian Mine Services Ltd. in 1966, Mr. Norton worked with the following companies:

1961 - 1965	--	The Anaconda Company (Canada) Ltd., at Britannia Beach, B.C., Canada.
1960 - 1961	--	The Anaconda Iron Ore (Ontario) Ltd. Project in Port Arthur and Nakina, Ontario, Canada.
1955 - 1960	--	The Chile Exploration Company at Chuquicamata, Chile, South America.
PRIOR	--	The Anaconda Company smelter in Anaconda, Montana.

He is a member of the Canadian Institute of Mining and Metallurgy and the American Institute of Mining, Metallurgical, and Petroleum Engineers.

RICHARD CRAWSHAY
Senior Vice President, Technical Services
Canadian Mine Services Ltd.

Richard Crawshay has over 30 years experience in the design and manufacture of machinery, coupled with first hand knowledge of the operation and maintenance of a wide range of mining equipment.

He became involved with mining in 1951 at the Canadian Exploration Ltd. Mine at Salmo, B.C., one of the early trackless operations. There, he became responsible for the maintenance and overhaul of all the underground diesel powered equipment. This was a period of trial for the new trackless mining method and much experience was gained by exposure to equipment largely adapted from surface machines by suppliers whose knowledge of underground conditions was limited.

Mr. Crawshay became deeply involved in the modification and adaption of this equipment to meet the demands made upon it, and contributed to the design of some of the first trackless mine drilling jumbos.

In 1955 he joined Letson & Burpee Ltd., Engineers and Machinery Manufacturers of Vancouver, B.C., who served the mining and other major industries in Western Canada. During fifteen years with this company, he became Works Manager, and in later years, was involved in the design of products and production machinery with particular emphasis on mechanization.

He joined Canadian Mine Services Ltd. in 1972 to establish a Research and Development group. Since then he has contributed to the development of our Superdrill diamond drill, and in-line-loader, trackless haulage and support vehicles, and shaft sinking equipment.

He is dedicated to the development of safer, more productive mining and diamond drilling machinery, which will match the innovation demonstrated by the planning and operational groups within the Company.

K. A. HAWRELAK, B. Comm., C. A.
Vice-President - Finance
Canadian Mine Services Ltd.

Kenneth A. Hawrelak graduated from the University of Alberta in 1970 with a Bachelor of Commerce degree. He articled with an international firm of chartered accountants in Toronto, Ontario, and obtained his C. A. from the Institute of Chartered Accountants of Ontario in 1975. He was admitted as an associate member of the Institute of Chartered Accountants of British Columbia in 1976 and is also a member of the Canadian Institute of Mining and Metallurgy.

Mr. Hawrelak joined Canadian Mine Services Ltd. in 1976 and has held various positions within the company leading to his appointment as Vice President - Finance and Assistant Secretary in 1980.

PETER M. CAIN
Vice President, Engineering
& Mining Development

Peter M. Cain graduated in 1965 from Queen's University with a Bachelor of Applied Science degree. He is a registered professional engineer in British Columbia, Ontario, and Yukon Territory.

From 1965 to 1967 he worked for Southwest Potash Corporation of Canada Ltd. in Carlsbad, New Mexico as a mine engineer. From 1968 to 1970 he worked at Heath Steele Mines Ltd. in Newcastle, New Brunswick as a mine engineer and then as Assistant Mine Superintendent.

From 1971 to 1975 he worked for Amax Exploration, Inc. in Toronto as a Mine Evaluation Engineer.

In 1976 he joined Canada Tungsten Mining Corporation Limited as General Manager. In 1978 he became Vice President of Operations responsible for all company operations and exploration activities.

He joined Canadian Mine Services Ltd. in 1982 as Vice President - Engineering and Mining Development.

GEORGE VOORO
President
Canadian Based Subsidiaries

George Vooro started his mining career at Campbell Red Lake Gold Mines Ltd. in 1946. He subsequently worked for Giant Yellowknife Gold Mines Ltd., Pioneer Mines Ltd., Bralorne Mines Ltd., and Bralorne Pioneer Mines Ltd.

His expertise in the mining industry has been acquired through his personal involvement in many underground track and trackless operations since 1946. His experience includes years as a practical miner using a wide variety of methods and equipment, and in a supervisory capacity through all levels of responsibility.

He joined Canadian Mine Services Ltd. in 1963, becoming General Manager and Vice President of Operations in 1967, and since 1977, as Senior Vice President.

In 1980, he was appointed President of Canadian Subsidiary Companies of Canadian Mine Services Ltd. He remains a Director of the parent company.

He is a member of the Canadian Institute of Mining and Metallurgy and the Prospectors and Developers Association.

C.D. (Bud) MacDONALD, P.Eng.
Senior Vice President
Western Canada Operations

C. D. (Bud) MacDonald is a 1964 graduate of the Nova Scotia Technical College with a Bachelor of Engineering and Master of Engineering in civil engineering. He has done post graduate research in Theoretical Soil Mechanics and is a registered professional engineer in British Columbia.

Prior to joining Canadian Mine Services Ltd. in 1969, he was involved in test installations and quality control on a large earth fill dam in central Canada and was Branch Manager for an Eastern Canadian consulting firm.

Since 1969 Mr. MacDonald has been actively involved in the development of our new hydraulic drills. He has also acted on a consulting basis to the Homestake Mine Company and the Anaconda Company on their in-house diamond drilling departments.

Mr. MacDonald is a past director of the Canadian Diamond Drilling Association, a member of the Canadian Institute of Mining and Metallurgy, and a member of a number of U.S. Mining Associations.

JOE TATAK, P. Eng.
Senior Vice President
Eastern Canada Operations

Joe Tatak is a graduate of Ostrava University, Czechoslovakia with a degree in Mining Engineering. His background covers all phases of the company's activities and spans more than 25 years.

His assignments have included work on reserve estimates, evaluations, exploration work, economic feasibility studies, expansion programs, new shafts, open pit mining and development planning. These studies have concerned such minerals as coal, clay, bentonites, kaolin, potash, uranium, and lead-zinc-copper ores in Europe and Canada.

Prior to imigrating to Canada to join Brunswick Mining and Smelting Corp. Ltd. (Noranda Group), Joe held various positions in Czechoslovakia including mine captain, general mine foreman, chief engineer and mine manager. He later worked as chief mine engineer with International Minerals and Chemicals Co. Ltd. in Saskatchewan before joining Canadian Mine Services in 1976.

Joe has since held positions of increasing responsibility and is currently responsible for all of the company activities in Eastern Canada. He has been involved in feasibility studies for new mining ventures, property evaluations, mine design and shaft planning. Joe has been instrumental in the development of innovative mining methods and equipment to mine orebodies that would have been uneconomical to mine by conventional methods.

Mr. Tatak is a Registered Professional Engineer in the Provinces of British Columbia and Ontario and member of the Canadian Institute of Mining and Metallurgy.

ELI ELIEV
Vice President, Mining
Eastern Canada Operations

Eli Eliev has 29 years experience in mining, covering projects from Newfoundland to the Yukon, including a period in Haiti. He has travelled extensively in Canada and abroad and is fluent in seven languages.

His early mining experience was gained in the Val'd'Or, Cobalt, and Chibougamau camps, where he progressed to the position of Shiftboss.

He spent seven years in Haiti, West Indies, where he worked as a Mine Captain and then as Mine Superintendent.

Since 1967, he has been employed by mine contractors in senior supervisory capacities at numerous projects. His assignments have included the complete pre-production development phase of a mine, initial development of an orebody, ramp development in perma-frost and water bearing strata, mine production employing a variety of stoping methods and high speed development programs using both track and trackless methods.

In 1974 he joined the CM Group as Project Manager and has worked at numerous projects including Granduc Mines Ltd., Grum Joint Venture, Mattabi Mines Ltd., Newfoundland Zinc Mines Ltd., Denison Mines Limited, and Agnew Lake Mines Limited.

He was appointed Manger of Mining, Eastern Canada, in 1978, and to the present position in May 1980.

F. W. 'BILL' HALES, P.Eng.
Vice President, Mining
Western Canada

Bill Hales is a 1957 graduate of the University of British Columbia in Mining Engineering. Following six years in mining operations, he returned to the University of British Columbia to study Business Administration, receiving his M.B.A. in 1966.

His professional career began with two years of mining and underground supervision at Lynn Lake, Manitoba, for Sherritt Gordon Mines Ltd., followed by three years of mine engineering at Stanrock Uranium Mines Ltd., in Elliot Lake, Ontario. He also worked for Discovery Mines Ltd., in the Northwest Territories, dewatering a small gold mine.

After his graduate work, Bill joined Newmont Mining Corp. in New York, where he was involved in evaluating investment opportunities. Later he transferred to the Magma Copper subsidiary in Superior, Arizona, when a major mine expansion was undertaken.

In 1970, he began consulting work, first with Wright Engineers Ltd. in Vancouver, and then with J. S. Redpath in North Bay, Ontario. In 1975, Bill formed his own firm. He has worked on feasibility studies for several large mines and prepared reports on a variety of mining methods, including block caving, large diameter blasthole and trackless open stoping.

After being closely associated with Canadian Mine Services Ltd., for several years, he joined the firm in 1978. Mr. Hales became Vice President, Mining, for the CM Group's Western Canada Operations in January 1982.

Bill is a member of the Canadian Institute of Mining and Metallurgy, the American Institute of Mining, Metallurgical and Petroleum Engineers, and the Mining Club of New York. He is a registered professional engineer in British Columbia and Ontario.

LORNE A. ST. LOUIS, B.A., M.B.A.
Controller - Eastern Operations

Lorne St. Louis graduated from the Univeristy of Waterloo in 1973 with his B.A. degree which included concentration in the areas of economics, computer science and accounting.

Following graduation from the University of Waterloo, Lorne obtained admission to and completed his Masters of Business Administration degree from the University of Western Ontario.

Lorne spent two years in public accounting while working for Peat, Marwick, Mitchell & Co. in the Toronto area performing audits and supervising staff on a wide variety of clientele.

In addition, Lorne obtained controllership experience in the fast food industry prior to joining the CM Group of companies.

As Controller of Eastern Operations, Lorne is responsible for all accounting functions in the administrative offices and on job sites. He has supervised large numbers of staff and has expertise in systems development. Lorne is a member of the Canadian Institute of Mining and Metallurgy.

ANGUS J. McDOUGALL, P.Eng.
President
U.S. Based Subsidiaries

Angus J. McDougall received a Bachelor of Applied Science degree in Mining Engineering in 1950 from the University of British Columbia. He is a registered professional engineer in the Province of British Columbia, a member of the CIMM and the AIME.

During the earlier years of his career, Mr. McDougall held various supervisory and engineering appointments in both Eastern and Western Canada.

From 1961 to 1963 he held the position of General Superintendent of the Britannia Mine, British Columbia, a 2000 ton per day underground copper mine.

In 1963 he joined the Granby Mining Company as Manager of Jedway Iron Ore Ltd., an open pit iron mine. He was transferred in 1965 to Granisle Copper Ltd. to assume the duties of the Resident Manager for the development and construction of a 5000 ton per day open pit mine and plant. After this mine was brought into production, he remained Resident Manager for a period of three years.

Mr. McDougall joined Canadian Mine Services Ltd. in 1968 as Assistant Manager of Operations. In 1973 he was appointed to the position of Vice President of Engineering. As Vice President, Engineering, he conducted special consulting assignments within the broad framework of the mining industry on a worldwide basis. These assignments included feasibility studies, construction of facilities, and production mining programs.

In 1977 he became a Senior Vice President of Canadian Mine Services Ltd. and was responsible for all of the operations of the U.S. subsidiary companies.

In 1980, Mr. McDougall was appointed President of American Mine Services, Inc. and all U.S. subsidiary companies. He resides in Denver, Colorado, location of head office for U.S. operations.

JOHN C. FOLINSBEE, P.Eng.
Executive Vice President,
CM, Inc.,
American Mine Services Ltd.

John Folinsbee is a 1951 mining geology graduate of the University of Toronto and is a Registered Professional Engineer in the Provinces of Ontario, Manitoba, British Columbia and the State of Nevada. He has many years of operating experience in the mining industry in positions of responsibility ranging from Shiftboss in underground mines to Chief Geologist, Chief Engineer, Mine Superintendent, Manager of Mining, Manager of Operations, and Acting General Manager.

Mr. Folinsbee has been responsible for feasibility studies, design, development, and operation of underground and open pit mines.

From 1953 to 1956, he was Chief Engineer and Chief Mine Geologist for Opemiska Copper Mines (Que.) Ltd., Chapais, Quebec.

This was followed by a year with Northspan Uranium Mines Ltd. in Elliot Lake as Chief Engineer and General Mine Foreman, and two years as underground Shiftboss for Kerr Addison Mines Ltd., Virginiatown, Ontario.

From January 1959 to September 1973, at Sherritt Gordon Mines Limited, Lynn Lake, Manitoba, he successively held positions of Mine Captain, Mine Superintendent, Manager of Mines, and Manager of Operations.

In September 1973, he joined Tara Mines Limited, Navan, County Meath, Republic of Ireland, and served in the capacities of Manager of Mining and Acting General Manager.

From September 1976 to May 1980, Mr. Folinsbee was responsible for consulting engineering services for Canadian Mine Services Ltd.

Currently, he holds responsibility for all operating functions of American Mine Services, Inc.

BILL LANE
Vice President - Engineering
U.S. Operations

Bill Lane graduated from the Michigan Technology University in mining engineering in 1959 and continued with post graduate work in rock mechanics and operations research at Penn State University.

Following graduation, he worked as a Junior Engineer for United States Steel at an open pit mine in Minnesota.

In 1961 he moved to New Mexico to become Mine Engineer and subsequently Project Engineer and Chief Mine Engineer for Kerr McGee's new underground potash mine. He was responsible for all planning, geology, and grade control.

At White Pine Copper Co., from 1968 to 1973, Bill held the positions of Senior Project Engineer, Boring Division Superintendent and Mine Services Superintendent. His responsibilities included the operation and maintendance of the major underground crushing and conveying system, a 12,000 h.p. mine ventilation system, all major rock support, construction of all underground facilities, driving an 18' diameter tunnel, 10,000' long, with a Robbins Tunnelling machine, and assisted in the development of the Atlas Copco double headed boring machine.

Bill spent two years with the Bunker Hill Corporation as Mine Maintenance Superintendent responsible for all maintenance and manufacturing for four mines in the Coeur d'Aline District.

Prior to joining CM, Bill was Mine Manager and later Manager of Special Projects for Dravo Lime Co. His responsibilities included design, development and start-up of a large underground mine in Kentucky. Subsequently, he was responsible for co-ordination of economic and technical data for project feasibility and capital expenditure planning for Dravo Lime Co.

Bill has published several technical papers on mining methods.

DON W. WEDDELL
Vice President - Mining
U.S. Operations

Don Weddell is a graduate of the Provincial Institute of Mining, Haileybury, Ontario.

Don's knowledge of the mining industry has been gained through his experience in various supervisory and management positions, with companies in Canada and abroad. This experience has covered mine production, mine engineering, heavy construction and sales.

From 1950 to 1952 he was a Mine Engineer and Foreman in Nicaragua, C.A., and from 1952 to 1957 he was with Placer Development Ltd. in British Columbia, holding the positions of Shiftboss and Mine Engineer.

During the period 1957 to 1959, Don was Mine Captain for Stanrock, Elliot Lake, Ontario. From 1959, through to 1974, he held positions in technical sales and management with C.I.L. and Ingersoll-Rand in Western Canada. In 1975 he was sself-employed in the Heavy Construction Industry in British Columbia.

Don joined the CM Group in 1976 as a Project Engineer, assigned to the Denison Project, Elliot Lake, Ontario, later becoming Project Manager.

In his capacity of Project Manager, Canadian Mine Enterprises Ltd., Denison Project, Don was responsible for contract mining operations, shaft and mine rehabilitation, and related engineering studies.

In 1978 he was transferred to the U.S. Operations as Manager of Mining and presently serves in the capacity of Vice President.

JAMES R. LAMB
Controller
U.S. Operations

Jim Lamb graduated in 1962 from the University of Nebraska at Omaha with a B.A. in Business Administration and Accounting.

From 1958 until his joining the CM Group in 1978, Jim was employed by Peter Kiewit Sons Co., Omaha, Nebraska. He began by working in all accounting departments throughout the company, learning the functions of each department, and progressed to District Job Office Supervisor for Home Office Tunnels District, travelling throughout the U.S. and Canada, monitoring all accounting and contract administration for underground construction, and reporting to the District Manager on financial status and construction schedule on projects.

Following this, Jim became Business Manager for Peter Kiewit Sons Co. and Brown & Root, Inc., a joint venture for the construction of the Eisenhower Memorial Tunnel. This was a $102,000,000 contract with the Colorado Department of Highways.

Jim also served two years in the U.S. Marine Corps and is a member of the International Accountants Society.

SENIOR OPERATING STAFF - CANADA

G. Vooro	President Canadian Based Subsidiary Companies
C. D. MacDonald	Senior Vice President Western Canada Operations
J. I. Tatak	Senior Vice President Eastern Canada Operations
P. Cain	Vice President Engineering and Mining Development
E. Eliev	Vice President - Mining Eastern Canada Operations
F. W. Hales	Vice President - Mining Western Canada Operations
J. Wright	Assistant to President Canadian Based Subsidiary Companies
G. Pierobon	Manager - Mining Eastern Canada Operations
J. McCutcheon	Manager - Diamond Drilling Western Canada Operations
J. Cossarini	Area Superintendent Western Canada Operations
T. Maule	Area Superintendent Western Canada Operations
R. Roy	Construction Manager

SENIOR ENGINEERING STAFF - CANADA

C. D. MacDonald	Senior Vice President Western Canada Operations
J. I. Tatak	Senior Vice President Eastern Canada Operations
P. Cain	Vice President Engineering and Mining Development
A. Malkin	Chief Mechanial Engineer
P. White	Chief Mining Engineer Eastern Canada Operations
A. Steward	Chief Mining Engineer Western Canada Operations

JOHN R. WRIGHT, P. Eng.
Assistant to President
Canadian Based Subsidiary Companies

John R. Wright graduated from Queen's University, Kingston, Ontario, in 1970 with a B.Sc. in Mining Engineering.

Upon graduation, he worked from 1970 to 1973 for Sherritt Gordon Mines Ltd. at Lynn Lake, Manitoba. He held various positions including Blasthole Engineer, Shiftboss, Planning Engineer, and Chief Engineer of the Central Planning Group. During his period as Shiftboss, John was in charge of longhole drillers and blasters. The operating mines under the central planning group produced 2,500,000 tons/year from blasthole mining.

From 1974 to 1977, John worked at Cominco's Con Mine in Yellowknife as Planning Engineer and Mine Engineer.

In 1977 he joined the CM Group as Project Engineer at the Denison Project, Elliot Lake, Ontario, where he was involved in feasibility studies and supervising Canadian Mine Enterprises Ltd.'s on-site Engineering Group. Production methods included jacklegs and slushers, jumbo mining, and longhole mining. Mine development was done with L.H.D. equipment and alimaks. Mr. Wright moved to Assistant Project Manager at Denison in 1978. During the spring of 1979 he supervised the start-up of the Stanrock Project. From here Mr. Wright joined the Engineering Division at the Bramalea Office.

He has considerable experience preparing feasibility studies, expansion programs, new mining methods, development programs, and long range scheduling and planning.

Mr. Wright is a Registered Professional Engineer in the provinces of Ontario and Alberta.

GUILIO PIEROBON
Project Manager

Guilio started working in underground mining in 1951 and in contracting in 1963.

He gained his mining experience at the Bralorne Mines Ltd. as a miner from 1951 - 1960 and at the Cariboo Gold Quartz Mine in Wells, British Columbia, from 1960 - 1963.

In 1963, Guilio began his contracting career as shiftboss at Jedway Iron Mines, B.C. and in 1964 moved to the Yukon Territory and worked as superintendent at United Keno Hill, Arctic Mine, and Venus Mine. His assignment continued on various contracting projects in Western Canada as project superintendent and project manager until 1973.

From 1973 - 1980, Guilio spent 7 years in Ireland as Project Manager at Tara Mines Limited. The work consisted of shaft sinking and 40,000 feet of trackless development, stope preparation, and training a complete mining crew that led to the successful operation of the mine. The training was completed in 1980 and Guilio came back to Canada to become Manager of our projects in Eastern Canada. In this capacity, he is responsible for mine development, safety, training, and economics of the operations.

J.S. 'JACK' McCUTCHEON
Diamond Drilling Manager,
Western Operations

Jack McCutcheon became involved with the diamond drilling industry in 1965 by working as a diamond drill helper between university terms. He worked for six summers as helper and then driller on numerous programs both surface and underground.

In 1972, Jack operated as Project Manager on a large surface core drilling program, being responsible for all on-site administrative duties.

During 1972, Mr. McCutcheon worked as a technical advisor on a consulting program to the Homestake Mining Company's in-house drilling department, where he was directly responsible for training of crews and introduction of new technology.

Since 1972, Jack has been involved in an administrative capacity, preparing tenders, providing cost and performance analysis, working with various associations involved with driller training programs, and co-ordination of field operations.

JOHN COSSARINI
Western Area Superintendent

John Cossarini is a 1970 graduate from the British Columbia Institute of Technology, with a Diploma in Mining Technology.

Prior to his technical training, John worked for Echo Bay Mines Ltd., N.W.T., as a development miner involved in raising, drifting, and stoping. He also gained underground experience while working for Eldorado Nuclear Ltd., Saskatchewan.

From 1970 to 1973 he was Job Superintendent/Supervisor for Canadian Mine Services Ltd., where he was involved in on-site supervision, timekeeping, engineering reports, job schedules, and inventory control on several projects. He also did a time, method and cost study of a shaft sinking project to evaluate the efficiency of present methods and to develop new techniques.

In June 1973 John joined R.F. Fry Associates (Pacific) Ltd., as General Superintendent, and remained with them until 1978. His responsibilities in this position included bidding, purchasing, equipment selection, job schedules, contract execution, and business development.

John re-joined the CM Group in January 1978 as Western Area Superintendent, having direct responsibility for all mining operations in Western Canada.

In addition to his formal education, John holds a valid B.C. Shiftboss Certificate and participated in a management seminar sponsored by Finning Tractor.

THOMAS MAULE
Area Superintendent - Western Operations

Tom Maule joined the CM Group as a development miner in 1965. Between 1965 and 1972 Tom worked in shaft sinking, raising, and drifting, both conventional and trackless.

In 1973 Mr. Maule moved into supervision as a shiftboss and mine foreman. During this period he worked on large underground trackless development programs at Cantung Mine and Granduc Mine.

Mr. Maule moved to Newfoundland Lead-Zinc Mine as Project Superintendent for CM in the Fall of 1974. Tom continued as Project Superintendent responsible for major underground mine development programs such as the Grum Project near Faro Yukon, Agnew Lake Mines, Cassiar Asbestos, Denison No.1 Shaft Project, and Kitsault Mine Project.

In the Spring of 1980, Mr. Maule moved to Stewart, B.C. as CM's Senior Project Superintendent to start the Scottie Gold Mine program. Here, he successfully drove 9000 feet of access tunnel in a 4 month period and proceeded to excavate an underground crushing plant, mill, access plant, and power plant in the following 3 months.

After working as Project Manager for the Denison Project in Elliot Lake, Mr. Maule transferred to Vancouver. He is currently employed as Area Superintendent - Western Operations.

ROMEO ROY
Construction Manager

Romeo Roy began his career in construction work in 1946 at the Dickenson Red Lake Mine, where he was a sawmill operator and framed shaft and headframe timber.

From 1947 to 1951, Romeo continued with construction work at the Campbell Red Lake Mine, where he also did contract framing of shaft timbers. Following the shaft work, he was involved in equipment installation.

In 1951 Romeo became General Superintendent for Commercial Home Builders Company Limited, a general contractor, whose specialty was industrial construction and steel fabricating, mostly for turnkey projects.

In 1972 he continued with similar work as a self-employed General Contractor in industrial construction.

In October 1978, Mr. Roy joined Canadian Mine Services as Construction Manager with responsibility for CM's office and plant construction in Bramalea and other construction work associated with mining contracts. Since then he has supervised the construction of a shaft sinking plant at the Clover Hill Potash Project in New Brunswick, including two shaft collars, as well as the installation of a major underground crushing plant at Denison Mines No. 2 Shaft in Elliot Lake, Ontario. He was also responsible for the site installation of the underground gold mill on the Scottie Gold Property in British Columbia, in addition to directing other mine plant construction projects across Canada.

ARTHUR W. MALKIN, P. Eng.
Chief Mechanical Engineer

Arthur W. Malkin received his Bachelor of Science degree with honours in Mechanical Engineering in 1965 from the University of Strathclyde, Glasgow, Scotland. He is a Registered Professional Engineer in the Province of Ontario, a Chartered Engineer, a member of the Institute of Mechanical Engineers in Great Britain, and a member of the Canadian Institute of Mining and Metallurgy.

After initial training in production coal mines, Mr. Malkin held various engineering positions with the National Coal Board in the U.K., finally joining the N.C.B. Research and Development Department in London, England.

He moved to Canada in 1966 as Plant Engineer at Duval Potash Mine during shaft sinking and progressed to Western Division Plant Engineer located in Tucson, Arizona. He was appointed Chief Plant Engineer for Cementation Canada/America Ltd. in Toronto and held that position until 1974.

Transferred to the U.K. he was engaged as Senior Design and Development Engineer on the Selby New Mine Complex in England.

Mr. Malkin joined Canadian Mine Services in 1979 as Chief Mechanical Engineer and is responsible for mechanical design and the mechanical, electrical and civil support construction section of the CM Group.

During his period with the CM Group he has been involved in conveyor, crusher and hoist installations, structural design and detail for mine services. Recent projects include the design of an internal shaft for the Granduc Project and the underground mill construction for Scottie Gold Mines Ltd. Current projects include the mechanical and structural design of the Underground Research Laboratory for Atomic Energy of Canada Limited.

PETER WHITE, P. Eng.
Chief Mining Engineer
Eastern Canada Operations

Peter White graduated from Queen's University with a degree in Mining Engineering and later returned to complete a Master's Degree in Business Administration. His background includes technical, supervisory, and administrative duties on several mining projects across Canada and overseas.

Following graduation, Peter joined J.S. Redpath Ltd. and was responsible for project engineering on a number of underground construction and development contracts and supervision of raise boring operations. He later worked as mine engineer for Lynx Canada Exploration Ltd. and as Chief Engineer for Consolidated Churchill Copper Corporation Limited.

Prior to joining the Engineering Group of Canadian Mine Services in 1979, Peter was with Mattagami Lake Mines Ltd., Lyon Lake Division at Ignace, Ontario where he was Project Engineer during the construction and development of the Lyon Lake and Mattabi underground operations.

As Chief Mining Engineer, he is responsible for technical and economic evaluations related to various mining and construction projects, as well as the development of engineering practices required to support the activities of the engineering group. Peter has been recently supervising a number of major conceptual and detailed engineering projects for clients such as Amax Inc., Gulf Canada Resources Ltd. and Atomic Energy of Canada Limited.

Peter has been designated as a Consulting Engineer by the Association of Professional Engineers of the Province of Ontario, and is a member of the Canadian Institute of Mining and Metallurgy, the Project Management Institute and the American Association of Cost Engineers.

ALLYN J. STEWARD, P. Eng.
Chief Mining Engineer
Western Canada Operations

Allyn Steward graduated from the University of Saskatchewan with a Bachelor of Science in Mining Engineering in 1967. Following graduation he was employed by Sherritt Gordon Mines Limited and remained there until 1970. He was employed in various capacities in the mine engineering department and underground supervision at Sherritt's Fox and Lynn Lake Mines.

In 1970 he joined McIntyre Porcupine Mines Ltd., and was employed in the mine engineering department, specifically dealing with gold operations.

Between 1971 and 1980 Mr. Steward was employed by Western Mines Ltd., initially as Chief Engineer, a position he held for five years and subsequently as Mine Superintendent for three years. In 1980 he held the position of Manager for the Western Mines operation in the Pine Point area.

Mr. Steward has been with Canadian Mine Services since 1980 and has been responsible for providing engineering services to the Western Operations of the CM Group and for consulting assignments for Western Canadian clients in the mining and construction industries.

He has been involved in cost estimating and engineering design for major tunnel projects including railway tunnels serving the North Eastern British Columbia coal deposits.

Mr. Steward has also directed mine feasibility studies including methods selection and operating and capital cost estimates and was project leader for a structural design assignment for the Scottie Gold Mines Limited crusher installation and cyanide mill.

SENIOR OPERATING STAFF - U.S.

A. J. McDougall	President American Mine Services, Inc. U.S. Based Subsidiary Companies
J. C. Folinsbee	Executive Vice President American Mine Services, Inc.
D. Weddell	Vice President - Mining U.S. Operations
W. H. Lane	Vice President - Engineering U.S. Operations
D. Legault	Manager - Mining U.S. Operations
B. Walker	Area Manager - Mining U.S. Operations

SENIOR ENGINEERING STAFF - U.S.A.

J. C. Folinsbee	Executive Vice President American Mine Services, Inc.
W. H. Lane	Vice President - Engineering U.S. Operations
A.H. Summers	Chief Mining Engineer U.S. Operations

DON LEGAULT
Manager, Mining
U.S. Operations

Prior to his joining the CM Group, Canadian Mine Services Ltd., in 1974, Don Legault had accumulated wide experience in the Mining Industry.

A shaft miner in 1953, Don was soon in a supervisory capacity, in charge of shaft sinking projects for Wilroy Mines, Manitowadge, Ontario, Can Met Mines, Blind River, Ontario, and Madsen Red Lake for Boland Development Ltd.

He joined Texada Mines as a Shiftboss in 1962, was promoted to Planning Engineer in 1967 and worked in that capacity until 1971. From 1971 to 1973 he worked as a Special Project Engineer in charge of two of Texada's small mines.

During the year 1973, he was Resident Manager for Columbia River Mines, where he was in charge of the rehabilitation of the mine and four months production work.

In 1974, after joining the CM Group, Don was transferred to American Mine Services, Inc., as Project Superintendent for the deep level shaft sinking contract for Homestake Mining Company, Lead, South Dakota.

After completing this contract in mid 1976, Don was moved to the shaft sinking project in Grants New Mexico as the Project Manager.

In early 1977 Don was promoted to Regional Superintendent responsible for the operations and administration of all mining projects in the Western U.S.A.

WILLIAM WALKER
Area Manager, Mining

Bill graduated from the Camborne School of Mines, Cornwall, England in 1960, with the equivalent of a B.S. degree in Mining Engineering. Later, in 1979, he received his M.B.A. degree from the West Virginia College of Graduate Studies.

In 1960, Bill joined Cementation Company of Great Britain as an Assistant Engineer and became involved in sinking shafts and driving tunnels for coal mine development. In 1961, Bill took the position of General Underground Engineer and Shiftboss of the Ghana State Mines Corporation in W. Africa. He returned to England in 1964 and again went to work for Cementation Company and became involved in sinking 1600' ventilation shaft through water bearing strata.

For close to ten (10) years, Bill worked with Cementation Company of Canada in various positions. He was a Shift Engineer responsible for the sinking of two (2) shaft and slope sinking projects in West Virginia for Carmelton Industries, Allied Chemical Company, Westmoreland Coal Company and Consolidated Coal Company.

In 1977, and until he recently joined A.M.S., as an Area Manager, Bill was an Area Manager for Cementation Company of America, Inc. He was totally responsible for all coal field projects.

Bill is a member of the American Institute of Mining Engineers and of the English Institute of Mining and Metallurgy.

REPRESENTATIVE CONTRACTING EXPERIENCE

REPRESENTATIVE CONTRACTING PROJECTS

LOCATION	DESCRIPTION	YEAR
Newfoundland & Labrador Hydro Cat Arm Development Jackson's Arm, Newfoundland	Trackless excavation of 5000 metres of Power & Forebay Tunnels, including access adits; installation, concreting, and grouting of steel penstock.	Current
Denison Mines Limited Elliot Lake, Ontario	60,000'+ Trackless Development Uranium Ore Pillar Recovery, Shaft Rehabilitation, Crusher Installation	1975 to date (1982)
Ibex Mining Company Sumpter, Oregon	General rehabilitation of surface facilities, underground drifts, sampling and support engineering.	Current
B.C. Hydro Downie Slide Project, British Columbia	Excavation of Drainage Tunnels and Drilling of Drain Holes	Current
Denison Mines Limited Clover Hill Potash Project Sussex, New Brunswick	Surface Plant Construction, Shaft Sinking, Grouting of Weak Water Bearing Ground, Mine Exploration and Development	1979 to date (1982)
Jerome Mining Corporation Humboldt, Arizona	Shaft sinking	Current
Coors - American Mine & Mill Fairplay, Colorado	Mill construction and mine evaluation	1981-1982
Sunshine Mining Company Silver Peak, Nevada	4000' decline, 2000' drift raise boring	Current

REPRESENTATIVE CONTRACTING PROJECTS

LOCATION	DESCRIPTION	YEAR
Giant Yellowknife Mines Limited Salmita Project, Northwest Territories	Dewater and Rehabilitate Existing Decline, Extend Decline and Drive Exploration Opening; Aircraft Supported Project	1982
Denison Mines Limited Elliot Lake, Ontario	Excavation of a Service Ramp from Surface to the Upper Levels of Existing Mine Workings	1982
Muscocho Explorations Limited Montauban, Quebec	Preproduction Development and Production Mining	1981
E & B Explorations Bralorne Mine, British Columbia	Mine Rehabilitation and Dewatering of Track Development and Hoisting Shafts	1981
Inland Cement Cadomin Quarry, Alberta	Excavation of a Gyratory Crusher Station; 16 m diameter Ore Bins, 70 m high; Trackless Development	1981-1982
Canada Tungsten Mining Corporation Tungsten, Northwest Territories	Alimak Raising and Trackless Drifting	1981
Sherritt Gordon Mines Ltd. Agassiz Project Lynn Lake, Manitoba	Shaft Dewatering and Deepening; Level Drifting	1981

REPRESENTATIVE CONTRACTING PROJECTS

LOCATION	DESCRIPTION	YEAR
Scottie Gold Mines Ltd. Near Stewart, British Columbia	18,000'+ Trackless Development and Mill Construction	1980-1981
Homestake Mining Company Moab, Utah	6000' decline	1980-1981
McCracken Silver Arizona	Design/construct open pit mine and operate mine and mill	1980-1981
Phillips Uranium Nose Rock Project New Mexico	Sink a 15' diameter, 3200' deep concrete lined shaft through ground grouted to control water in-flows	1980
Mountain Minerals Parsons, British Columbia	Exploration, Design, 15,000'+ Development and Mining of Barite Ore	1979-1981
Newmont Mines Ltd. Trout Lake Project	7,500' Track Development, Grouting, Portal and Plant Construction; Bulk Sampling	1979-1981
Amok Ltee Cluff Lake Project Cluff Lake, Saskatchewan	5,000' Development and Bulk Sampling of Uranium Ores	1979-1981

REPRESENTATIVE CONTRACTING PROJECTS

LOCATION	DESCRIPTION	YEAR
American Borate Company Death Valley, California	4600' drift	1979-1980
Rio Blanco Oil Shales Project Rio Blanco, Blanco County, Colorado	2700' + shaft sinking, raise boring, raising and level development	1978
United Nuclear Homestake Partnership Section 13 Mine Near Grants, New Mexico	Installing surface plant and headframe, sinking 792' of shaft, equipping the shaft and driving 3000' of level development	1976
Homestake Mining Co. Homestake Mine Lead, South Dakota	Excavate and support a hoistroom and rope raise in extremely heavy ground, sink a 1250' winze and a 400' shaft, drive levels and develop new stopes	1975
Tara Mines Limited Navan, Ireland	+40,000' Trackless Development, Shaft Sinking, Mine Constructing and Training	1973-1980
Canada Tungsten Mining Corporation Tungsten, Northwest Territories	20,000' Trackless Development	1973-1975
Granduc Mines - Newmont Stewart, British Columbia	80,000' Trackless Development, Tunnel Construction	1966-1974

REPRESENTATIVE ENGINEERING PROJECTS

CLIENT	DESCRIPTION	YEAR
World Bank Hazara Phosphate Project Pakistan	Site visit and preliminary report on a developing mining project.	1982
Steel Brothers Canada Limited Lime Division Cache Creek, British Columbia	Preliminary cost estimate for drift and raise excavation, crusher and conveyor installation.	1981 to-date
Atomic Energy of Canada Buffer Development Program Pinawa, Manitoba	Associating with W.L. Wardrop & Associates in the conceptual engineering of the acquisition, preparation and emplacement of buffer/backfill material in a nuclear waste disposal vault.	Current
Denison Mines Limited Clover Hill Potash Project New Brunswick	Conceptual and detail design of surface mining plant, shaft sinking, mine development and exploration, including design of equipment and excavations; detail scheduling and cost estimates.	1979 to-date
Atomic Energy of Canada Underground Research Laboratory for WNRE, Pinawa, Manitoba	Associating with W.L. Wardrop & Associates in the engineering design of a 350 m shaft and associated underground laboratory excavations.	Current

REPRESENTATIVE ENGINEERING PROJECTS

CLIENT	DESCRIPTION	YEAR
Confidential	Detailed design of surface plant, 20' diameter shaft, stations, pumping facilities for 5000' deep shaft.	1982
Confidential	Conceptual design of shafts associated surface plant and underground stations for six shafts with total hoisting capacity 66,000 t.p.d.	1982
American Mine & Mill Fairplay, Colorado	Complete design, rehabilitation, and construction of 200 t.p.d. custom mill and evaluation of mine.	1981-1982
B.C. Rail Tumbler Ridge Branch Line	Work being performed in association with Klohn, Leonoff and Dolmage Campbell; design, preparation of contract specifications, and construction management for two rail tunnels, 15 km in total length.	1981
Dresser Industries Ltd. Deep sea mining	The design and economic evaluation of 52,000 t.p.y. ocean bottom barite deposit.	1981

REPRESENTATIVE ENGINEERING PROJECTS

CLIENT	DESCRIPTION	YEAR
Climax Molybdenum Corporation Mount Emmons Project Crested Butte, Colorado	Conceptual Design Study of a hydraulic backfill system for pillar recovery associated with a 7,000 t.p.d. blasthole stoping operation.	1981
B.C. Rail Tumbler Ridge Branch Line	Work performed in association with D.R. Piteau and Associates; detailed cost estimate and geotechnical review of two - 300 m long tunnels in northeastern British Columbia.	1981
Climax Molybdenum Corporation Model Construction	Fabrication and assembly of a scaled orebody model for a 30,000,000 ton tungsten deposit.	1981
Dolly Varden Minerals Inc. Northstar and Wolf Deposits Alice Arm, British Columbia	Evaluation and selection of mining methods; preparation of a detailed cost estimate for surface infrastructure, mine development, mill construction; mine and mill operating cost estimate.	1981
Trigg Woollett Consulting Anglo United Development Corp. Snare River Gold Project Northwest Territories	Design of trackless bulk sampling project requirements and preparation of preliminary cost estimate.	1981

REPRESENTATIVE ENGINEERING PROJECTS

CLIENT	DESCRIPTION	YEAR
Canada Wide Mines Limited Granduc Mine Hoisting System and Shaft Design Stewart, British Columbia	Structural design for rock hoisting system, including loading and dumping arrangements and shaft steel work for a Koepe hoist installation incorporating rope shaft guides.	1981
Atomic Energy of Canada Limited **Chalk River Nuclear Laboratories** Underground Repository for Reactor Waste Storage	Work performed with assistance from D.R. Piteau and Associates and Monserco Limited; conceptual design and preliminary cost estimate for an underground repository for the storage of reactor wastes.	1981
Climax Molybdenum Corporation Yorke-Hardy Project Smithers, British Columbia	Evaluation of mining methods, mine design and detailed cost estimates for 90,000,000 ton molybdenum deposit.	1981
Dresser Minerals Inc. Fireside Barite Project British Columbia	Open pit mine design; preliminary development and mining cost estimate.	1981
Atomic Energy of Canada Underground Waste Handling System	Associated with W.L. Wardrop & Associates in the conceptual design of an underground container handling system for transporting radioactive spent fuel containers to permanent underground storage.	1981

REPRESENTATIVE ENGINEERING PROJECTS

CLIENT	DESCRIPTION	YEAR
Denison Mines Limited Babcock Open Pit Tumbler Ridge, British Columbia	Prepared conceptual layouts and preliminary cost estimates for 10,000 t.p.h. pit waste handling system using vertical raises and tunnels beneath the open pit coal property; evaluated alternative methods of handling oversized material at the top of the raises.	1981
Scottie Gold Mines Limited Underground Mill Design Stewart, British Columbia	Detailed civil, mechanical and structural design of 200 t.p.d. gold mill constructed in underground excavated chambers.	1980-81
Gulf Canada Resources Inc. **Alberta Oil Sands Research Authority** Surmont Project Alberta	Comprehensive evaluation of technology for shaft sinking and tunnelling in conjunction with mine-assisted in-situ bitumen extraction from oil sands; preparation of preliminary construction cost estimates.	1980-81
Amax Northwest Mining Company Limited Mactung Project Yukon	Detail mine design, equipment selection and production scheduling for construction and 20 year mine life for large tungsten property; preparation of detail cost estimate for mine construction and operation.	1980-81

REPRESENTATIVE ENGINEERING PROJECTS

CLIENT	DESCRIPTION	YEAR
Mountain Minerals Limited Parsons, British Columbia	Geological evaluation and design of mining method for underground barite mine, including exploration, development, mine operation; preparation of detail cost estimates.	1980-81
Prism Resources Limited Vera - Kathleen Project Yukon	Preliminary cost estimate for the development and operation of an underground lead-zinc property.	1980
M.P.H. Consulting Limited Goldsearch Ltd. Project Quebec	Preliminary cost estimate for rehabilitation of underground workings for a detailed underground exploration program at a gold property.	1980
Canada Wide Mines Limited Midwest Lake, Saskatchewan	Prepared a preliminary cost estimate for sinking a 5 meter diameter concrete lined shaft at an underground uranium project.	1980
Denison Mines Limited Elliot Lake, Ontario	Prepared a comprehensive report on underground uranium ore methods using hydraulic backfill; evaluated mining methods, mining equipment selection, backfill characteristics, backfill handling system; prepared detailed cost estimate for backfill project.	1980

REPRESENTATIVE ENGINEERING PROJECTS

CLIENT	DESCRIPTION	YEAR
Amok Ltd. Cluff Lake, Saskatchewan	Conceptual design, detail design, equipment selection, procurement and fabrication of a portable bulk sampling plant for sampling uranium deposits.	1980
Denison Mines Limited Echo Bay Mines Limited Lupin Gold Project Northwest Territories	Evaluation of ore reserves, underground and open pit mining methods in permafrost; equipment selection; preparation of detailed cost estimates for development and operation of a gold mine in a remote location.	1980
Shell Canada Resources Limited East Kemptville, Nova Scotia	Conceptual surface and underground layout for bulk sampling operation for a tin property; preparation of detail cost estimates for sample plant erection and operation.	1980
Cima Resources Limited Mount Hundere Project Yukon	Open pit mine design; surface plant and mill layout; preparation of cost estimates for construction and operation of a lead-zinc-silver mine and mill.	1980
B.C. Rail Tumbler Ridge Branch Line	Detail cost estimate for the construction of two railway tunnels, total tunnel length of 15 km.	1980

REPRESENTATIVE ENGINEERING PROJECTS

CLIENT	DESCRIPTION	YEAR
Denison Mines Limited Cadillac Explorations Project Northwest Territories	Determination of mining methods and equipment for a 1000 t.p.d. mining operation; preparation of detail cost estimate for construction and operation off narrow vein silver property.	1980
Canada Wide Mines Limited Midwest Lake, Saskatchewan	Review of mine design and preparation of detail cost estimate for construction and operation of high-grade uranium mine; conceptual development of production equipment for handling high-grade uranium ore.	1980
Climax Molybdenum Corp. Lower Levels Study Climax, Colorado	Complete conceptual and detailed engineering design of 44,000 t.p.d. crushing and conveying system.	1979-80

REPRESENTATIVE UNDERGROUND DRILLING PROJECTS

CLIENT	DESCRIPTION	YEAR
Canada Tungsten Mining Corporation Tungsten, Northwest Territories	Completed 15,000 feet AQ drilling in short definition holes with Model 100 Superdrill. A world record of 3542 feet in one month was achieved with one crew working 26 - eight hour shifts.	Current
Wesfrob Mining Divisison Tasu, British Columbia Underground Exploration Coring	Drilled 22,000 feet AQ core, mostly up-holes.	Current
Cassiar Asbestos Corporation Limited Cassiar, British Columbia Cassiar Adit	Drilled in excess of 40,000 feet including HQ upholes in difficult formations	Current
Newmont Mines Limited Vancouver, British Columbia Trout Lake	Completed 72,000 feet of NQ and BQ Core in hard formations.	1981
Canada Wide Mines Limited Stewart, British Columbia	Completed 32,000 feet of core drilling in trackless environment with diesel Model 100 Superdrill.	1981
Westmin Resources Limited Campbell River, British Columbia	Completed 18,000 feet BQ drilling in holes to 2,500 feet in depth.	1981
Amok Limited Cluff Lake, Saskatchewan	Drilled in excess of 20,000 feet of short definition core drilling, of which 6,200 ft. was done in one machine month.	1981

REPRESENTATIVE UNDERGROUND DRILLING PROJECTS

CLIENT	DESCRIPTION	YEAR
Climax Molybdenum Corp. of British Columbia Ltd. Yorke Hardy Project Smithers, B.C.	Drilled in excess of 8,000 feet in large diameter up holes. Vertical up holes in HQ size were completed to depths of 500 ft.	1980
Jersey Miniere Zinc Company Gordonsville, Tennessee Gordonsville Mine	Drilled 20,000 feet AQ core in chert and quartzite formations.	1979
Amax Exploration Inc. Babbit, Minnesota Minnamax	62,000 feet BQ drilling completed in hard taconite formations.	1978
Agnew Lake Mines Ltd. Espanola, Ontario Agnew Lake Mine	Completed 100,000 feet of core drilling to date, in hard competent formations.	1978
White Pine Copper White Pine, Michigan White Pine Mine	Drilled 15,000 feet in limestone formations.	1978
The Anaconda Company Tooele, Utah Carr Fork	60,000 feet of NQ core drilling completed in broken quartz formations.	1978

REPRESENTATIVE UNDERGROUND DRILLING PROJECTS

CLIENT	DESCRIPTION	YEAR
Anamax Mining Company Tucson, Arizona Twin Buttes	Drilled 8,000 feet of BQ core underground in hard formations. Completed one hole to excess of 1,500 feet with Model 100 Superdrill.	1978
Canadian Natural Resources Limited Calgary, Alberta Grum Yukon Territory, Canada	Drilled 62,000 feet of underground core, drilling at BQ size involving all angles from vertical up to vertical down. Set world productivity record of of 6,488 feet in one machine month for BQ core underground.	1976
Cities Services Company Miami, Arizona Miami East Mine	Worked one year drilling extremely difficult formations. Drilled all sizes including HQ core on up holes.	1976
Homestake Mining Company Lead, South Dakota Homestake Mine	Provided consulting service to Homestake's in-house drilling division.	1975
The Anaconda Company Butte, Montana Stewart & Leonard Mines	Provided supervision, technical direction, and equipment for deep underground drilling through old stopes. NQ boreholes completed to over 2,400 feet in depth.	1975
Hecla Mining Company Casa Grande, Arizona Lakeshore Mine	Drilled 14,000 feet of BQ core in all angles from 11 foot arched drift. With 5 foot rods and core barrels drilled 240 feet in one 8 hour shift and 410 feet in last 24 hours on property.	1975

REPRESENTATIVE UNDERGROUND DRILLING PROJECTS

CLIENT	DESCRIPTION	YEAR
Amax, Inc. Empire, Colorado Henderson Mine	Tested Superdrill Model 100 and productivity was in excess of two times greater than on-site contractor with standard gear.	1974
Granduc Operating Company Stewart, British Columbia Granduc Mine	Drilled 153,000 feet of underground core in AQ holes of all angles.	1971

REPRESENTATIVE SURFACE DRILLING PROJECTS

CLIENT	DESCRIPTION	YEAR
Cassiar Resources Cassiar, British Columbia	15,000' large diameter core in difficult formations	1978, 1980 & Current
Riocanex, Inc. New Denver, British Columbia	20,000' core drilling in mountainous terrain; project included holes to 2800' in depth	1980-1981
Mountain Minerals Parsons, British Columbia	20,000' core drilling in winter conditions	1980-1981
Chevron Standard Harrison Hills, British Columbia	22,000' core drilling in mountainous terrain with mobile superdrill	1980
PNC Exploration (Canada) Ltd. Beaverdell, British Columbia	20,000' coring in unconsolidated formations	1979
Kerr Addison Mines Ltd. Faro Yukon Territories	Drilled 82,800 feet with unitized, skid mounted drill units	1975-1976
Amax Exploration Ltd. Minnamax Minnesota	Drilled 20,000 feet in boreholes to 2,500 foot depth, at 1 7/8" core.	1976

REPRESENTATIVE SURFACE DRILLING PROJECTS

CLIENT	DESCRIPTION	YEAR
Homestake Mining Company Pitch Mine Gunnison, Colorado	Drilled 13,000 feet of 2.5" diameter in soft sedimentary uranium deposit.	1976
Amax Exploration Ltd. Mactung Yukon Territories	Drilled 33,000 feet in fractured permafrost formation, using specialized drilling fluids.	1973
Amax Exploration Ltd. Kirwin Wyoming	Drilled 17,500 feet of core in one season at elevations to 13,000 feet, maximum depth of borehole 2,952 feet.	1974
Brameda Resources Ltd. Casino Silver Mines Ltd. Yukon Territories	Drilled 37,000 feet of core in loosely cemented porphyry deposit. Extensive application of mud solution as flushing agent and one of initial tests of coring rock with air foam flush. Total support by air.	1970

CANADIAN MINE SERVICES LTD.

HELICOPTER SUPPORTED DRILLING PROJECTS

CLIENT	DESCRIPTION	YEAR
D. R. Piteau & Associates Ltd. Roger's Pass British Columbia	Drilling in National Park to test proposed new CPR tunnel alignment in Roger's Pass	1981
Riocanex Inc. Williston Lake, B.C.	Drilling moves accomplished with "heavy lift" helicopter	1980
Esso Minerals Canada Ltd. Stewart, B.C.	Controlled drilling techniques including directional wedging operations in glacial terrain.	1980
Amax Exploration Ltd. Cochrane River, Saskatchewan	Summer coring project in Northern Saskatchewan	1980
Utah International Knights Inlet, B.C.	Helicopter supported project in rugged West Coast terrain	1979
Omni Resources Inc. Atlin, B.C.	Surface and underground drilling in rugged glacial terrain.	1979
Climax Molybdenum Corporation of B.C Limited Kitsault, B.C.	2,000 foot holes using controlled drilling techniques.	1978

CANADIAN MINE SERVICES LTD.

EQUIPMENT SPECIFICATIONS

October 1982

SPECIFICATIONS

CANADIAN MINE SERVICES' MODEL 1824 WATER COOLED DIESEL POWERED, FOUR WHEEL DRIVE CENTRE ARTICULATED 24 TON DUMP TRUCK, COMPLETE WITH:

ENGINE:
- CAT 3306 PCT TURBO CHARGED
- 210 HP @ 2200 R.P.M.

POWER TRAIN:
- CAT TORQUE CONVERTER
- CAT TRANSMISSION
- TWO SPEED FORWARD AND REVERSE
- CAT FRONT AND REAR AXLE
- 13° FRONT AXLE OSCILLATION

ELECTRICAL:
- 24 VOLT ELECTRICAL SYSTEM
- ELECTRIC START
- CAT GAUGES AND STANDARD INSTRUMENTS
- AUDIO VISUAL ALARM SYSTEM

BRAKE:
- HYDRAULIC EXPANDED TUBE SERVICE BRAKE
- SPRING APPLIED DRIVE LINE DISC EMERGENCY/PARK BRAKE

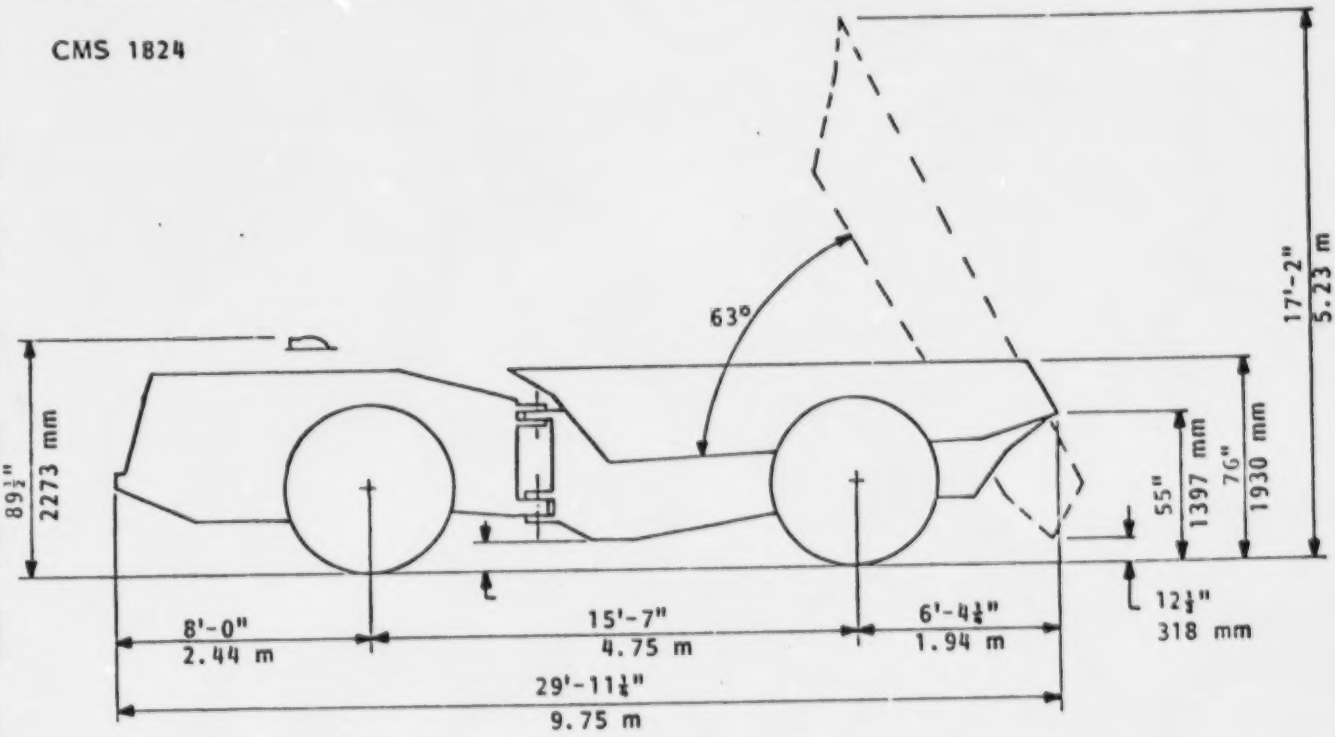
STEERING:
- HYDRAULIC STICK STEERING CONTROL
- DOUBLE THRUST BEARINGS MOUNTED CENTRE PIN TYPE HYDRAULIC STEERING

EXHAUST:
- MECRON OXY-CATALYST EXHAUST SYSTEM
- OPTIONAL WET TYPE SCRUBBERS

SPECIFICATIONS/Cont'd

BOX:	- 16 CU. YD. SAE HEAPED RATED BOX
TIRE:	- 18:00 x 25 32 PLY LUG RLS E4 C.T.R. TIRE
FIRE SUPPRESSION SYSTEM:	- ANSUL

CMS 1824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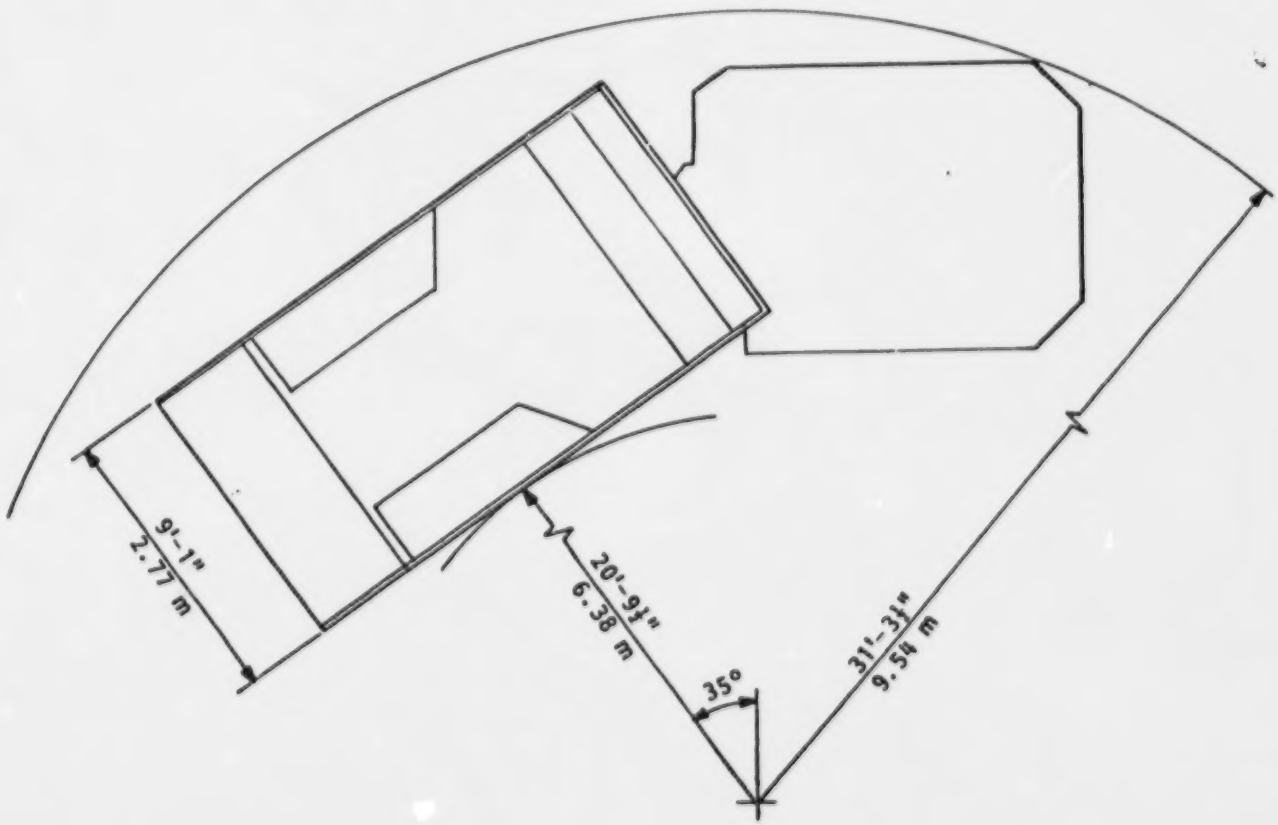
17'-2"
5.23 m
89½"
2273 mm
55"
1397 mm
76"
1930 mm
12½"
318 mm
8'-0"
2.44 m
15'-7"
4.75 m
6'-4⅛"
1.94 m
29'-11⅛"
9.75 m


9'-1"
2.77 m
20'-9¼"
6.38 m
35°
31'-3¼"
9.54 m

SPECIFICATIONS

CANADIAN MINE SERVICES' ELECTRIC DRILL JUMBO, FOUR WHEEL DRIVE CENTRE ARTICULATED JUMBO CARRIER, COMPLETE WITH:

ENGINE:

- PERKINS 4.236 WATER COOL
- 78 HP @ 2800 R.P.M.

POWER TRAIN:

- VARIABLE DISPLACEMENT PISTON PUMP (SUNDSTRAND 22-2058)
- HYDROSTATIC MOTOR (GECO K500FA1)
- FORD FRONT & REAR AXLE 4000

ELECTRICAL:

- 12 VOLT ELECTRICAL SYSTEM
- ELECTRIC START
- UCC GAUGES & STANDARD INSTRUMENTS
- AUDIO VISUAL ALARM SYSTEM

BRAKE:

- TOTALLY ENCLOSED OIL COOLED WET DISC SERVICE BRAKE
- SPRING APPLIED WET DISC EMERGENCY/PARK BRAKE

STEERING:

- HYDRAULIC STICK STEERING CONTROL

EXHAUST:

- MECRON OXY-CATALYST EXHAUST SYSTEM
- OPTIONAL WET TYPE SCRUBBERS

SPECIFICATIONS/Cont'd

WEIGHT: - 20,000 LBS.

DIMENSIONS:
- LENGTH 18' - 6¼"
- WIDTH 5' - 10"
- HEIGHT 4' - 11"

SPEED:		REVERSE	FORWARD
(M.P.H.)	MAX.	3.4	3.4

GRADABILITY: - 25% RECOMMENDED GRADE @ G.V.W.

SCRUBBER: - CATALYTIC PELLET TYPE

TIRES:
- 10:00 x 20
- 14 PLY RATING - R - LUG

FIRE EXTINGUISHER:
- DRY 10 LBS.
- TYPE A.B.C.
- HAND HELD

BRAKE HORSEPOWER: - 78 H.P.

SPECIFICATIONS/Cont'd

CAPACITIES:	- HYDRAULIC	35.7	IMP GALLONS
		43	U.S. GALLONS
	- FUEL	18.3	IMP GALLONS
		22	U.S. GALLONS

TRANSMISSION:

- HYDROSTATIC TRANSMISSION SYSTEM, ENGINE DRIVEN AXIAL PISTON VARIABLE DISPLACMEMENT PUMP WITH GEAR TYPE CHARGE PUMP, CONNECTED IN CLOSED LOOP SYSTEM, WITH HOLLOW SHAFT AXIAL PISTON. MOTOR IS CONNECTED TO THE DRIVE SHAFT LEADING TO FRONT AND REAR AXLES. THE OUTPUT OF THE ENGINE DRIVEN PUMP IS CONTROLLED BY A HAND LEVER WITH FAIL SAFE SPRING CENTERING DEVICE. MOVEMENT OF THE HAND LEVER ENABLES THE OPERATOR TO CONTROL VEHICLE SPEEDS FORWARD & REVERSE WITH INFINITE STEPLESS CHANGE WITHIN THE RANGE OF ZERO TO MAXIMUM.

BRAKES SERVICE:

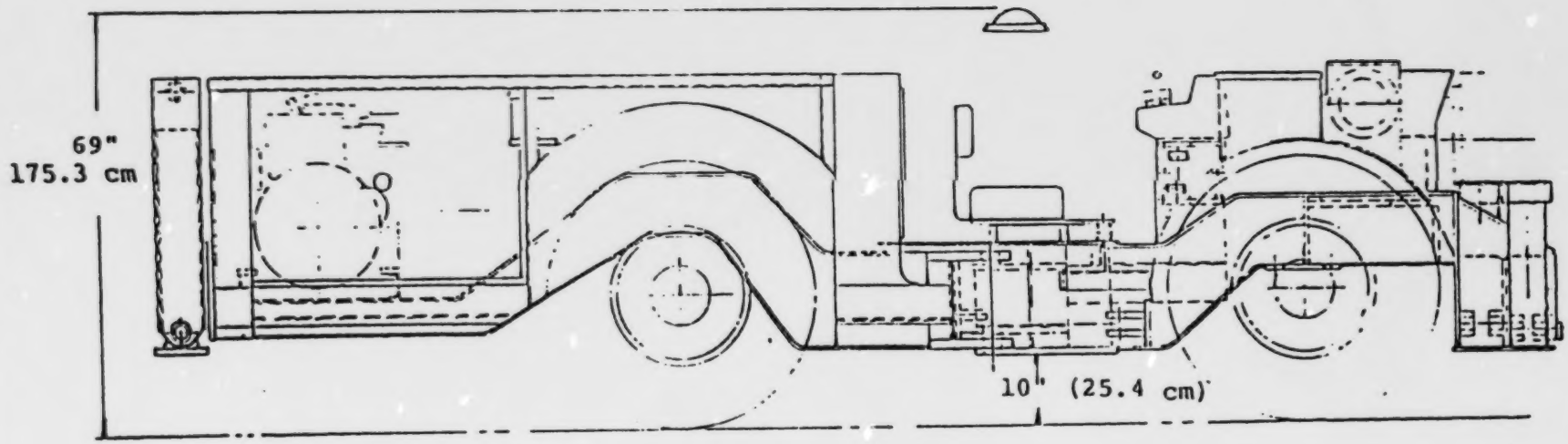
- TOTALLY ENCLOSED OIL COOLED WET DISC BRAKE

EMERGENCY:

- FAIL SAFE, SPRING APPLIED, HYDRAULIC RELEASED. TOTALLY ENCLOSED OIL COOLED DISC BRAKE, ONE ON EACH WHEEL.
- AUTOMATIC APPLICATION OF BRAKE OCCURS WITH THE LOSS OF HYDROSTATIC TRANSMISSION PRESSURE.

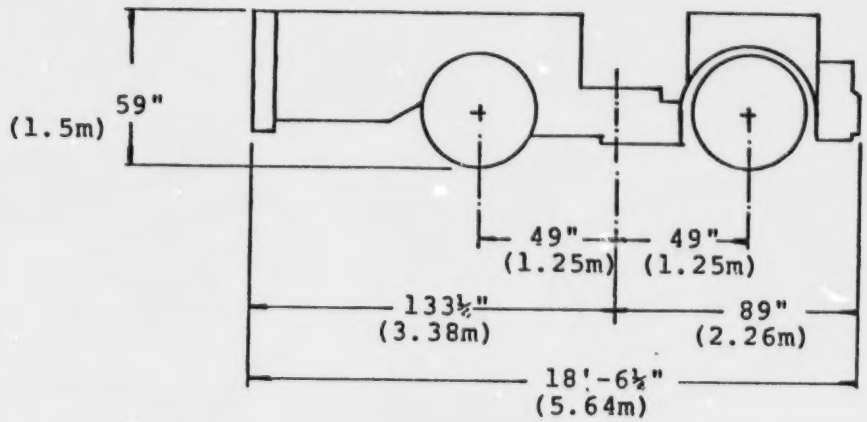
CANADIAN MINE SERVICES

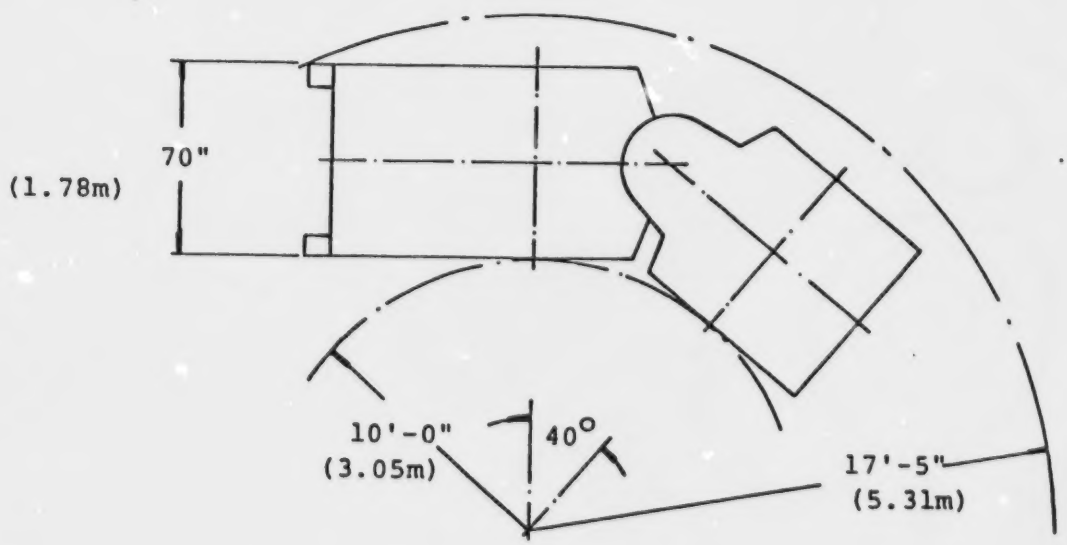
SBJ CARRIER



CANADIAN MINE SERVICES

SBJ CARRIER





SPECIFICATIONS

16 MAN PERSONNEL CARRIER

WEIGHT:
- NET 9,000 LB. (4082 KG)
- G.V.W. 18,000 LB. (8165 KG)

DIMENSIONS:
- LENGTH 19' - 10½" (6.06 M)
- WIDTH 6' - 5" (1.96 M)
- HEIGHT 5' - 11" (1.8 M)

SPEED:
- FORWARD - 8.5 M.P.H. (13.6 KM/H)
- REVERSE - 8.5 M.P.H. (13.6 KM/H)

GRADABILITY
- 25% RECOMMENDED GRADE @ G.V.W.

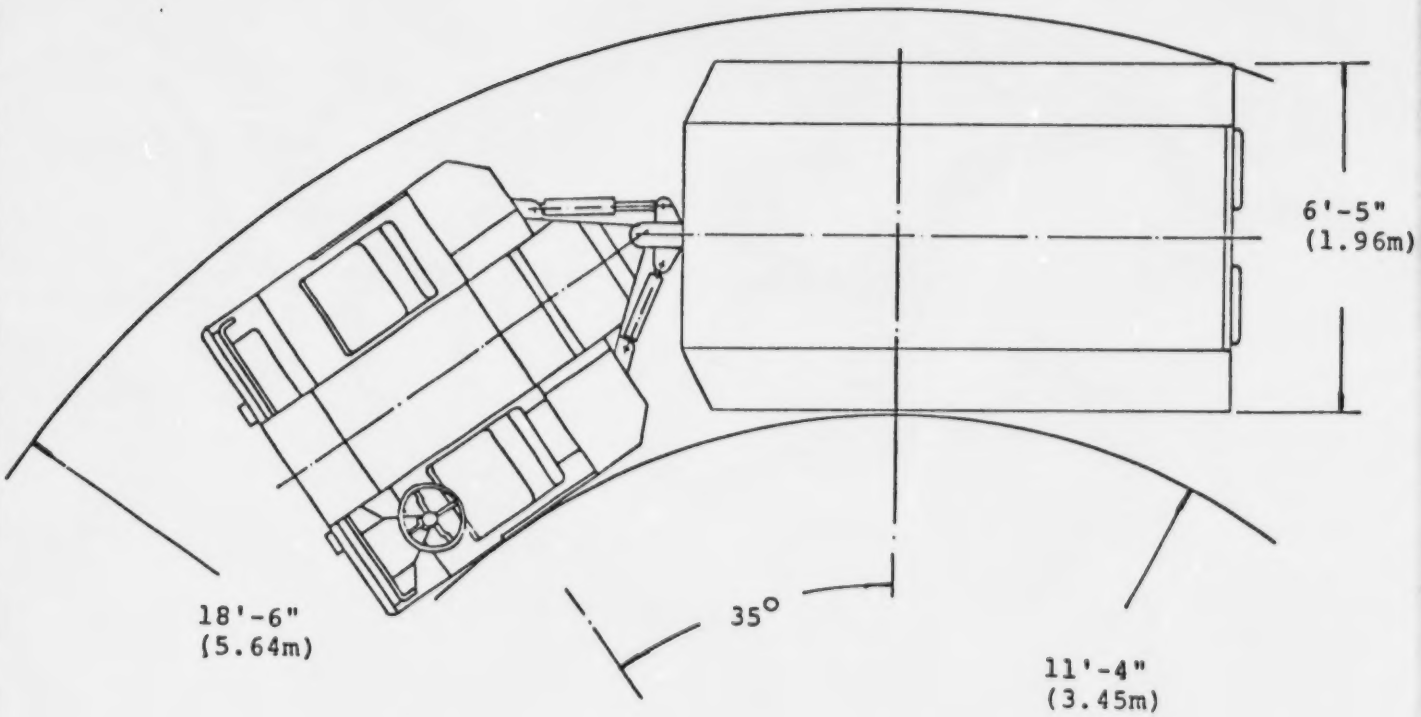
ENGINE:
- ISUZU MODEL Q.D. 90 NATURALLY ASPIRATED DIESEL
- 67 H.P. @ 2800 R.P.M.

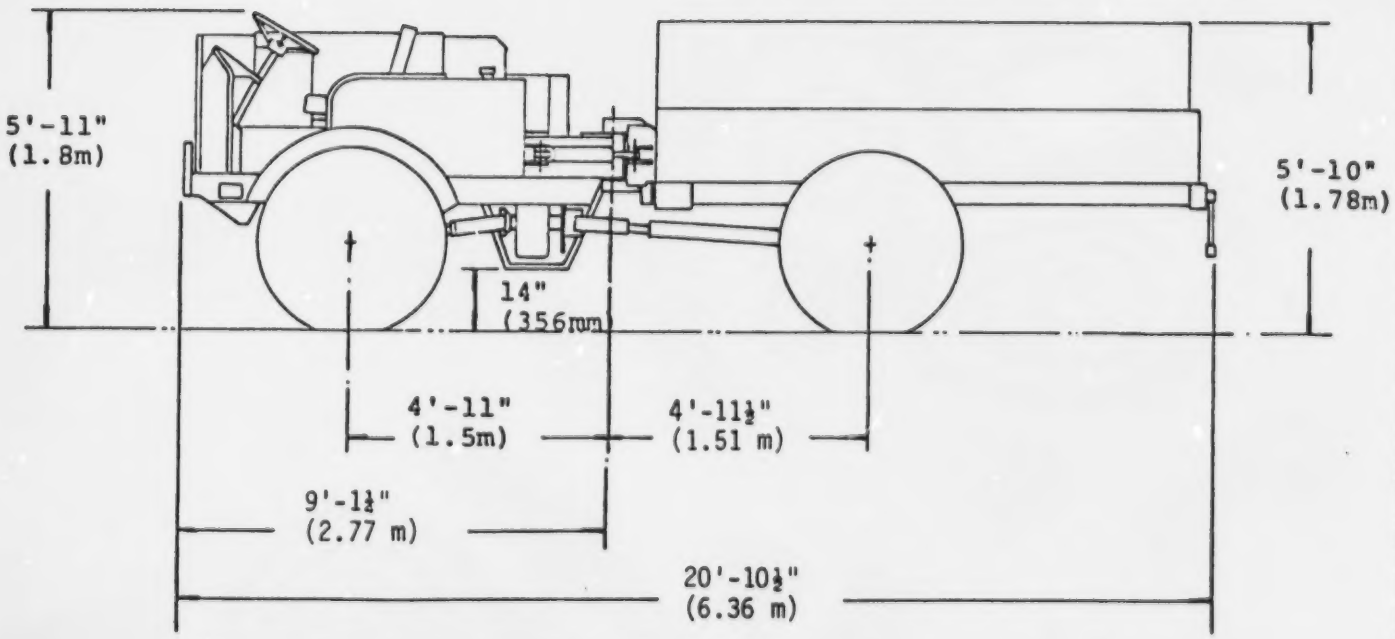
POWER TRAIN:
- FUNK FOUR SPEED POWER SHAFT TRANSMISSION
- FORD DINN 4000 AC AXLES, WITH FULLY ENCLOSED OIL BATH DISC BRAKES FOR EACH WHEEL

ELECTRICAL:		- 12 VOLT ELECTRICAL SYSTEM - ELECTRICAL START - VISUAL ALARM SYSTEM
BRAKES:	SERVICE	- FULLY ENCLOSED OIL BATH DISC BRAKE FOR EACH WHEEL - ACTUATED THROUGH DUAL HYDRAULIC MODULATING VALVES - ACCUMULATOR SYSTEM SUPPLIES PRESSURE IN THE EVENT OF LOSS OF POWER FROM ENGINE DRIVEN PUMP
	EMERGENCY	- SPRING APPLIED, HYDRAULIC RELEASED DRIVE LINE DISC BRAKE - AUTOMATIC APPLICATION WITH LOSS OF HYDRAULIC PRESSURE OR WITH LOSS OF TRANSMISSION PRESSURE
	PARK	- MANUAL APPLICATION OF EMERGENCY BRAKE
STEERING:		- HYDRAULIC WHEEL STEERING CONTROL - GEROTOR TYPE STEERING VALVE
EXHAUST:		- CATALYTIC OXIDATION EXHAUST PURIFIER - OPTIONAL WET TYPE SCRUBBERS
TIRES:		- 10.00 x 20 ML - 12 PLY - TUBE TYPE

FIRE EXTINGUISHER:

- DRY 10 LBS.
- TYPE A, B, C
- HAND HELD


6'-5"
(1.96m)
18'-6"
(5.64m)
35°
11'-4"
(3.45m)


5'-11"
(1.8m)
5'-10"
(1.78m)
14"
(356mm
4'-11"
(1.5m)
4'-11½"
(1.51 m)
9'-1½"
(2.77 m)
20'-10½"
(6.36 m)

CANADIAN MINE SERVICES LTD.

SPECIFICATIONS

2 MAN PERSONNEL CARRIER

WEIGHT: - 4,000 (1815 KG)

DIMENSIONS:

- LENGTH		12' - 0"	(3.66 M)
- WIDTH		5' - 5-3/4"	(1.67 M)
- HEIGHT (WITH ROLLBAR)		6' - 2"	(1.88 M)
	(WITH ROPS)	6' - 10"	(2.08 M)
- TURNING RADIUS (INSIDE)		7' - 7½"	(2.4 M)
-	(OUTSIDE)	14' - 1½	(4.3 M)

SPEED:

FORWARD	- 9.73 M.P.H. (15.57 KM/H)
REVERSE	- 7.02 M.P.H. (11.23 KM/H)

GRADABILITY: - 25% RECOMMENDED GRADE @ G.V.W.

ENGINE:

- PERKINS MODEL 4.108 NATURALLY ASPIRATED DIESEL
- 38 H.P. @ 2800 RPM
- U.S. MINE BUREAU APPROVED NO. 24/D75

POWER TRAIN:

- AUTOMOTIVE TYPE AUTOMATIC TRANSMISSION WITH HIGH STALL RATIO TORQUE CONVERTER & SINGLE SPEED TRANSFER CASE
- AUTOMOTIVE TYPE FRONT & REAR AXLE WITH HYPOLD DIFFERENTIAL

ELECTRICAL:

- 12 VOLT ELECTRICAL SYSTEM
- ELECTRIC START
- FRONT & REAR HEAD LIGHTS
- VISUAL ALARM SYSTEM

BRAKES:

SERVICE

- HYDRAULIC DRUM BRAKES ON ALL 4 WHEELS
- DUAL MASTER CYLINDER GIVES TWO INDEPENDENT SYSTEMS, ONE FOR EACH AXLE

EMERGENCY

- FAIL SAFE SPRING APPLIED, HYDRAULIC RELEASED, SINGLE DISC BRAKE INTEGRAL WITH TRANSFER CASE
- AUTOMATIC APPLICATION OF BRAKE OCCURS WITH THE LOSS OF TRANSMISSION PUMP PRESSURE

PARK

- OPERATOR ENGAGES EMERGENCY APPLICATION WITH THE USE OF A DASH MOUNTED CONTROL KNOB

STEERING:

- HYDRAULIC WHEEL STEERING CONTROL
- CAN BE MANUALLY OPERATED IN THE EVENT OF HYDRAULIC POWER FAILURE

EXHAUST:

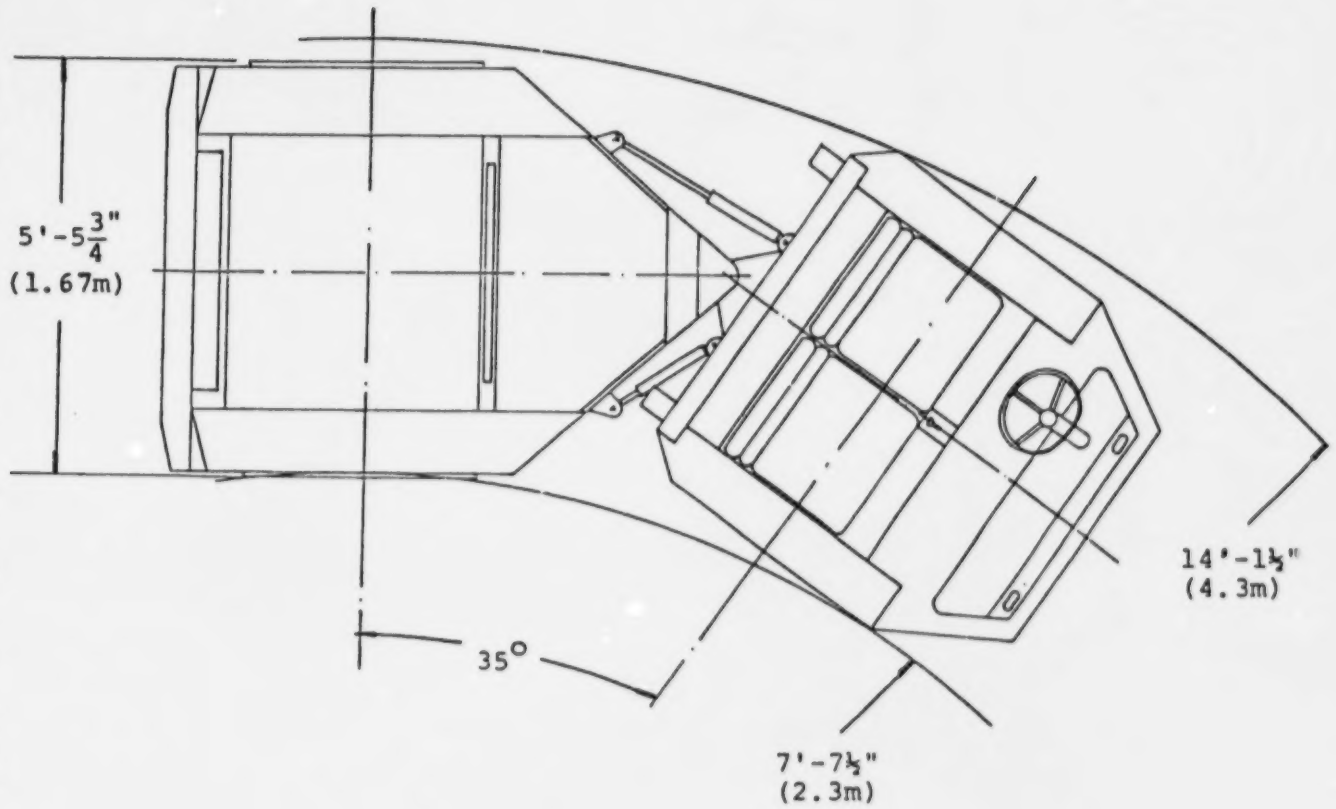
- CATALYTIC OXIDATION EXHAUST PURIFIER
-OPTIONAL WET TYPE SCRUBBERS

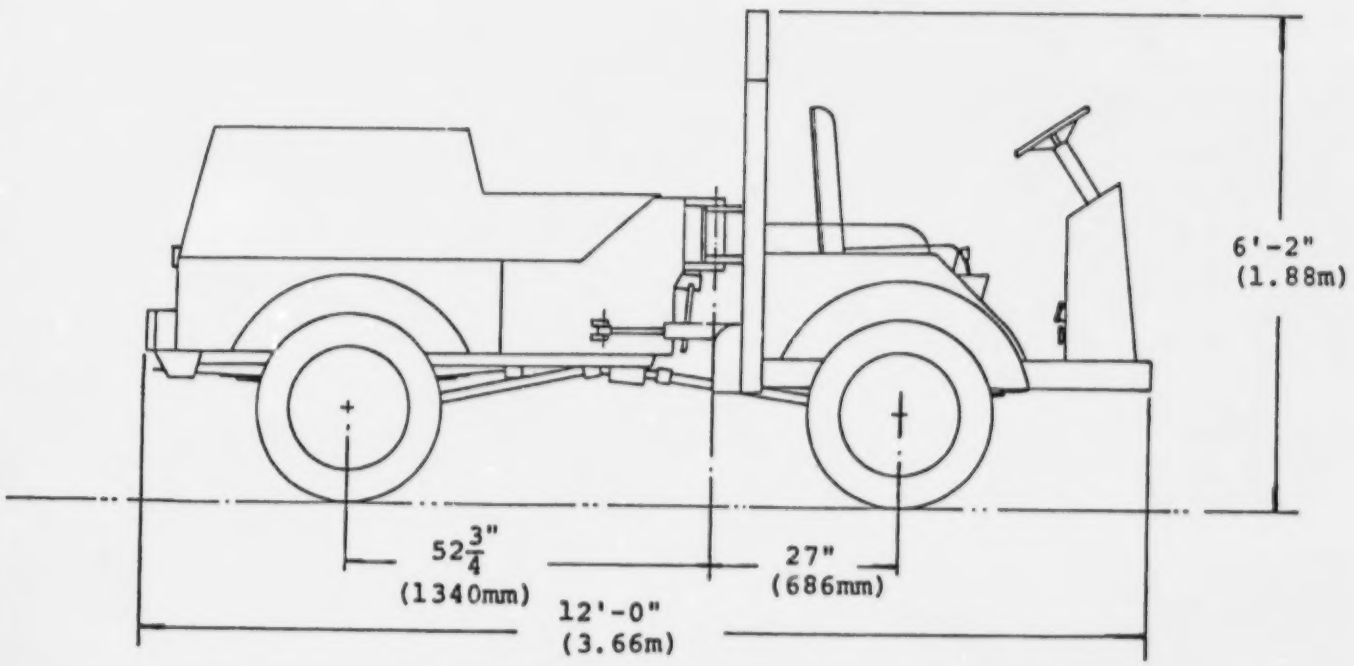
TIRES:

- 7.00 R15 LT
- 6 PLY 'C' RATING
- BRIDGESTONE STEEL BELTED RADIAL

FIRE EXTINGUISHER:

- DRY, 5 LBS.
- TYPE A, B, C
- HAND HELD


5'-5 3/4"
(1.67m)
35°
14'-1½"
(4.3m)
7'-7½"
(2.3m)

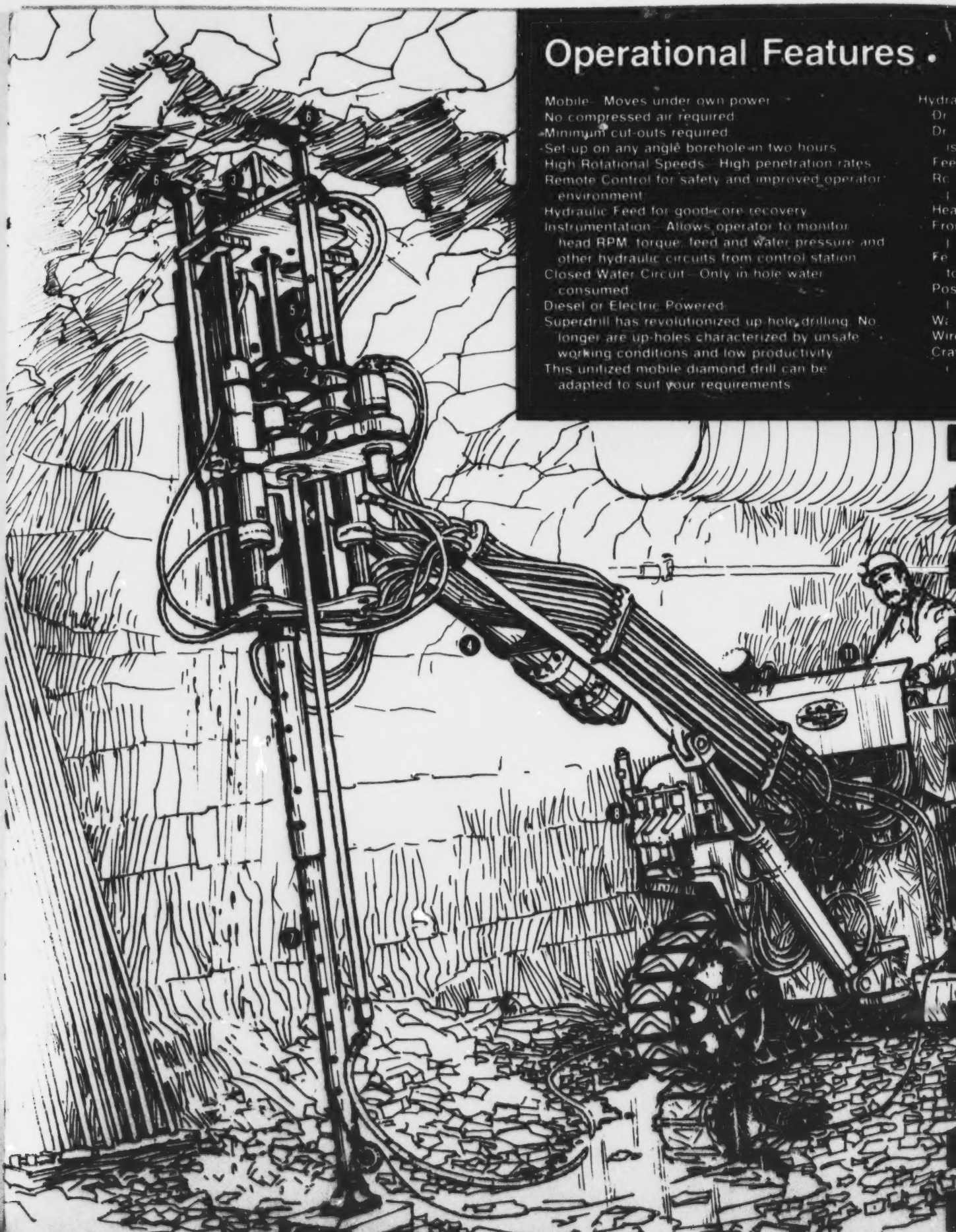

6'-2"
(1.88m)
52 3/4"
(1340mm)
27"
(686mm)
12'-0"
(3.66m)

SUPERDRILL

MARK II

MOBILITY & MECHANIZATION CONTRIBUTE TO...

Increased production
Reduced moving time
Faster set-ups
Centralized remote control
Reduced operator fatigue
Greater safety
More efficient power utilization

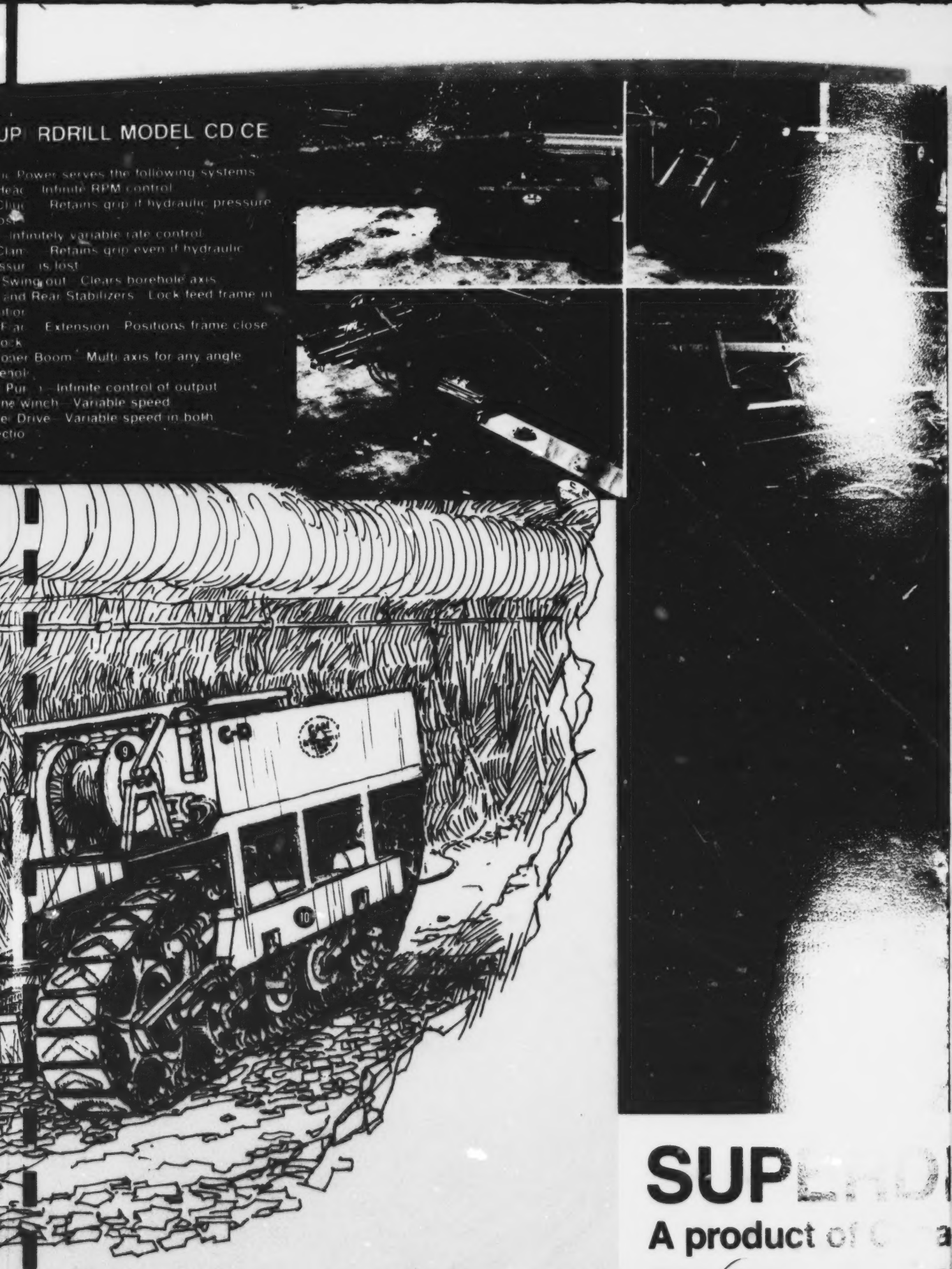


Operational Features

- Mobile – Moves under own power
- No compressed air required
- Minimum cut-outs required
- Set-up on any angle borehole in two hours
- High Rotational Speeds – High penetration rates
- Remote Control for safety and improved operator environment
- Hydraulic Feed for good core recovery
- Instrumentation – Allows operator to monitor head RPM, torque, feed and water pressure and other hydraulic circuits from control station
- Closed Water Circuit – Only in hole water consumed
- Diesel or Electric Powered

Superdrill has revolutionized up-hole drilling. No longer are up-holes characterized by unsafe working conditions and low productivity.

This unitized mobile diamond drill can be adapted to suit your requirements.


UP RDRILL MODEL CD CE
ic Power serves the following systems
deac Infinite RPM control
Clinc Retains grip if hydraulic pressure
os
infinitely variable rate control
Clam Retains grip even if hydraulic
ssur is lost
Swing out Clears borehole axis
and Rear Stabilizers Lock feed frame in
ator
Fair Extension Positions frame close
ock
oner Boom Multi axis for any angle
enol
Pur Infinite control of output
ne winch Variable speed
e Drive Variable speed in both
ctio
SUP
A product of

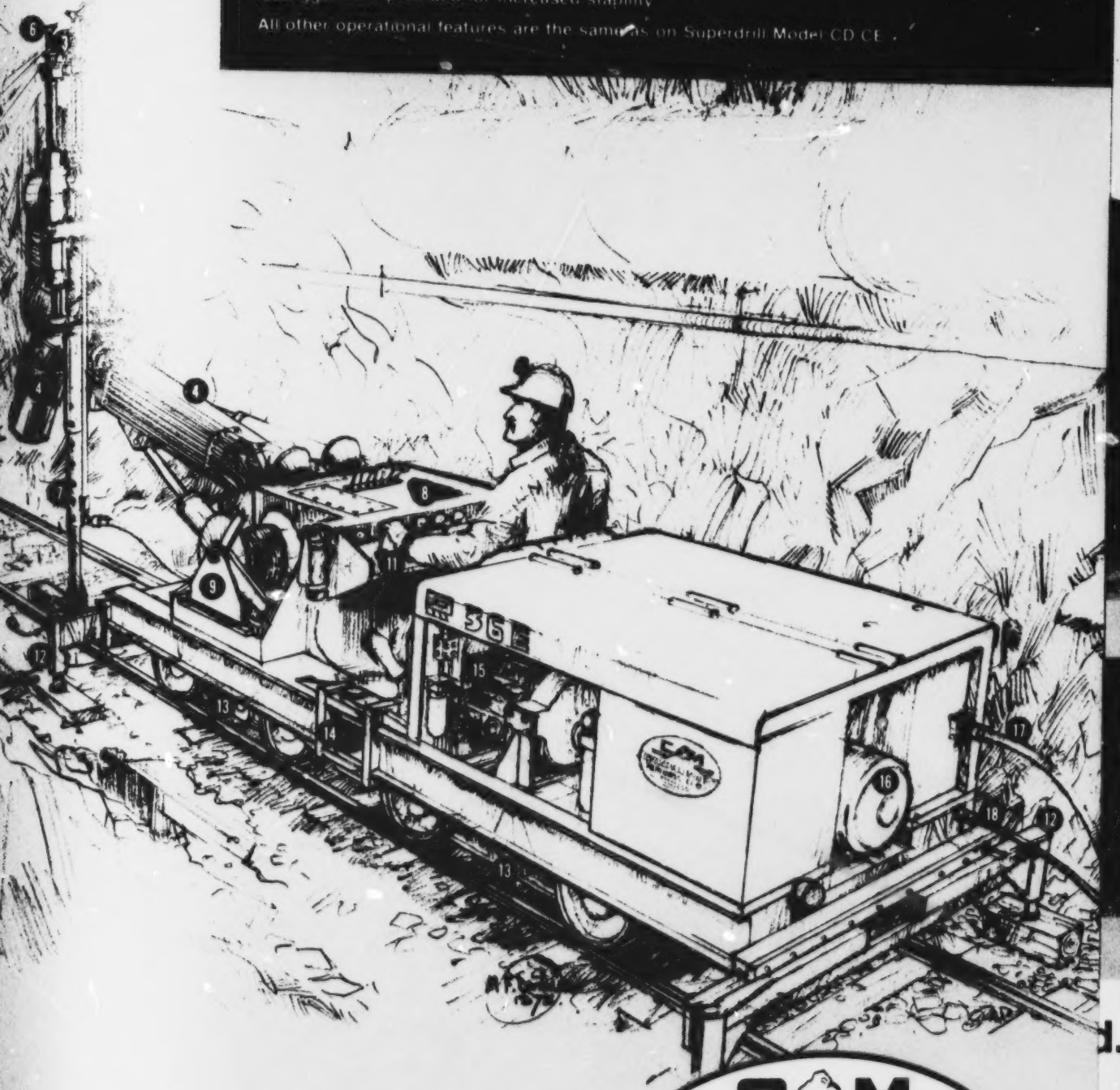
Operational Features • SUPERDRILL MODEL R.E.

This machine is moved from station to station by a conventional mine locomotive.

The boom is removable and the chassis can be separated into two small units to assist in cage hoisting or moving in close quarters.

Outriggers are provided for increased stability.

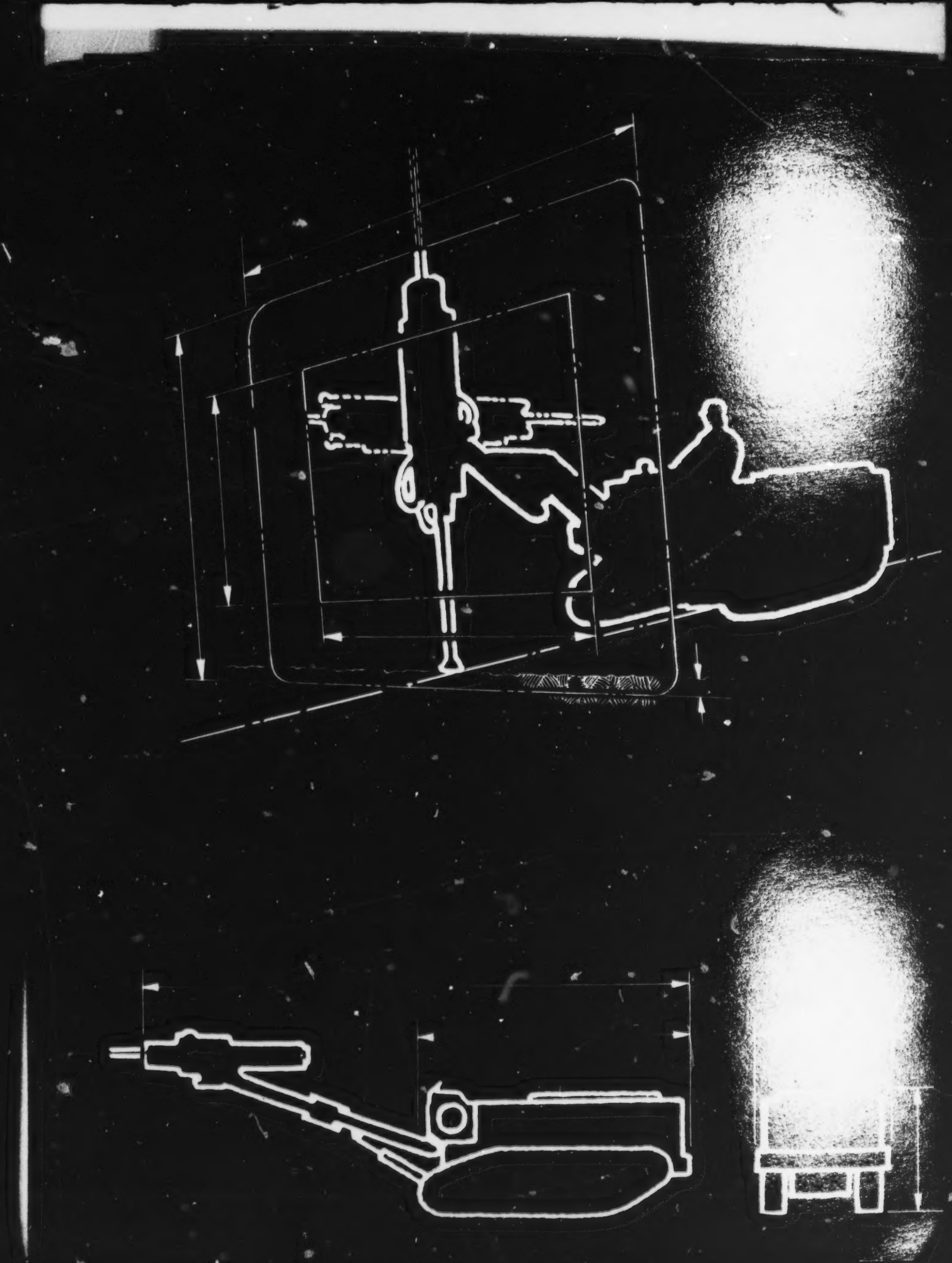
All other operational features are the same as on Superdrill Model CD CE.



RIL MARK II

an M Services Ltd.

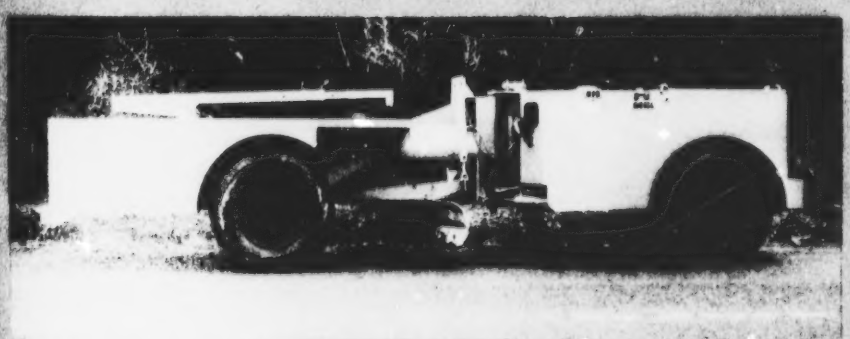
CANADIAN MINE SERVICES LTD.
VANCOUVER, B.C.



Other Products by Canadian Mine Services Ltd.

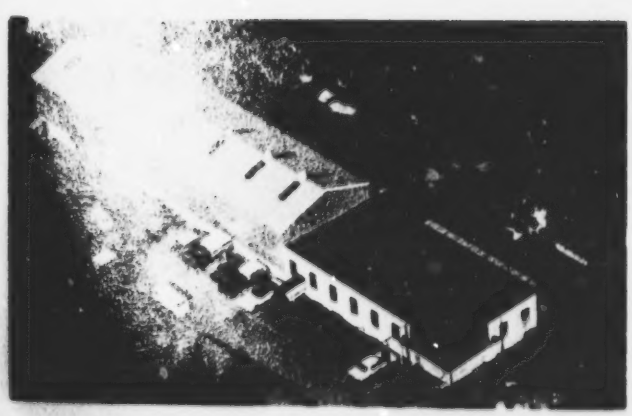
Mobile Diamond Drill

Rock Drill Jumbo



King [illegible] Service Vehicle

Hy-Grader



Canadian Mine Services Ltd.

CONTRACTORS

MINE DEVELOPMENT

DIAMOND DRILLING

CUSTOM EQUIPMENT
DESIGN AND MANUFACTURE

Engineering and Consulting Services

CANADIAN MINE SERVICES LTD.
VANCOUVER B.C.

745 CLARK DRIVE, VANCOUVER, B.C. V5L 3J3
Telephone: (604) 253-5251 Telex: 04-54311

LITHO'D IN CANADA

"SELECTING A MINING METHOD"

was presented by

J. C. Folinsbee, P.Eng.

at the

INTERNATIONAL CONFERENCE ON CAVING AND SUBLEVEL STOPING

sponsored by

the Mining & Exploration Division of

the Society of Mining Engineers of AIME

held in Denver, Colorado

November 1981

Chapter 5

Selecting a Mining Method

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Senior Vice President, Engineering

R. W. D. Clarke, P.Eng.
Mining Engineer

Canadian Mine Services Ltd.

INTRODUCTION

This paper deals with a procedure for planning the mining of an orebody for which cross-sections, plans, grade of ore, and a geological estimate of the ore reserve have been prepared.

The procedure begins with the preliminary selection of a mining method or methods on which an engineering evaluation will be carried out. The engineering evaluation is described in three parts:

Conceptual Studies

Engineering Studies

Detailed Design

An overall planning model is presented, plus an expanded model for the Engineering Study.

Throughout the discussion of the planning procedure, reference is made to three bulk mining methods, including block caving, sublevel caving, and longhole sublevel stoping, including a summary of the main characteristics of each of these mining methods. The planning model is designed for a longhole sublevel stoping method, but with modification, will apply to other methods.

PRELIMINARY SELECTION OF A MINING METHOD

To experienced mining engineers, identification of the nominal mining method for a given orebody normally involves a large measure of judgement. The geological data is reviewed to determine the configuration of the orebody, including size, shape, dip, grade, and metal distribution. Geotechnical data is considered, including the competence of the ore and host rock, faults, fracture patterns, groundwater, and the potential for insitu stresses. Geographical data, including the natural and societal conditions, are evaluated for their effect upon the mining method, and finally, economic data, basically defined as the value of the ore in the ground, but more specifically, including grade of mineable ore, distribution of ore grade throughout the orebody, and metallurgical recovery, will have a bearing on the nominal method selected.

Preliminary evaluation of these factors will result in the elimination of the obviously inappropriate mining methods, leaving some method or methods for further, more detailed study.

Since ore does not occur in simple geometric shapes, the method selected for more detailed study will require some variation to the standard. A few key factors will bear heavily on the selection and provide a basis for the most realistic choice.

Geological Data

The configuration of an orebody defined by the horizontal and vertical dimensions, the dip and strike, and the possibility of repetitive occurrences will have the major influence on the selection of the mining method.

For bulk mining methods, the dip of the orebody should be steep, or the orebody must be thick so that gravity can be utilized to deliver fragmented ore to a central gathering area.

Geotechnical Data

The geotechnical data will be studied in greater detail when the nominal mining method has been selected and the engineering evaluation is undertaken. However, some basic initial information must be available. The structural strength of the ore and host rock, including the effect on it of faulting, fracturing, and insitu stresses, must be known. Data from exploration drilling and examination of drill core will assist in the preliminary assessment of these factors. Highly fractured ground may suggest a caving method of mining for certain orebody configurations, whereas highly competent or strong ore might indicate that for a similar configuration, longhole sublevel stoping will more likely succeed.

Data obtained on groundwater from exploration drilling will be considered to determine if it can be controlled, or if it will represent a long term major expense or a hazard for which no control is possible.

SUMMARY - BULK MINING METHODS
Typical Features

Table 1

	Block Caving	Sublevel Caving	Longhole Sublevel Stoping
Geological:			
Dip	- steep or thick vertical dimension	- medium to steep or thick vertical dimension	- steep or thick vertical dimension
Strike	- not important	- not important, except changing strike may be a complication	- strike change may be a stability factor
Length & Width	- large orebody	- medium to large orebody	- small to large orebodies. Widths as low as 10' can be mined
Height of Block	- blocks 3-400', possibly higher	- not a major factor	- sufficient to justify drawpoint development. Upper limit approximately 400' normally, but may be higher in single stope, near vertical orebodies
Geotechical:			
Competency of Ore	- weak, fractured	- weak to strong	- medium to strong. Lower range sufficient to permit essentially unsupported development in ore
Competency of Walls	- stronger than ore	- weak, difficult or impossible to support	- medium to strong. Will be a major factor in determination of stope length and height
Subsidence	- yes	- yes	- not normally planned. Stopes may be backfilled or pillars left to support walls
Geographical:			
Surface Water	- must be minimal	- must be minimal	- some control is possible
Land Use	- must be low value	- must be low value	- less important than for caving methods
Reclamation	- not feasible	- not feasible	- feasible
Economic:			
Operating Costs	- low	- medium	- medium
Dilution	- medium	- high	- low from stopes; medium to high from pillars
Drawdown Control	- rigid	- rigid	- not important from stopes; rigid from pillars
Preproduction Development	- high	- moderate, but development accounts 25% ore production	- moderate to high
Selectivity	- nil	- nil	- some possible in terms of pillar placement
Equipment at Drawpoints	- trackless or scrapers	- trackless or track loaders	- trackless, track or scrapers. Current preference - trackless

Geographical Data

Geographical data include the natural conditions of topography and climate and the societal conditions of land use, existing communities, and environmental factors. The natural conditions are site-specific and must be given careful consideration in the selection of the mining method. One of the most obvious considerations is surface water. If lakes and rivers overlying the orebody cannot be drained or diverted within the expected profit framework of the operation, mining methods which will permit surface subsidence and subsequent water inflows may be eliminated. Even if water flows can be handled in the mine by pumping or drainage, the water may require treatment before it can be discharged to the environment.

Societal conditions, particularly the existence of a community, road, power line, or other structures over the orebody, may also dictate that a method of mining that permits subsidence cannot be used.

Nearby communities may provide a workforce for the mine, accommodation for future employees, or form the nucleus of a larger community. Existing communities may have an established labour cost base which will dictate that more or less mechanization will be required to ensure best operating performance.

Federal and local regulations for restoration and reclamation will have a bearing on whether a caving method can be used.

Economic Data

Regardless of the foregoing physical considerations, economics will have a major bearing on the determination of the mining method. An Owner's long term capital commitments, analysis of the market and profit requirements, will affect the decision on production rates. Grade of ore and concentrates, smelter recovery, and costs of transportation, smelting, refining, and marketing will impose some limitation on the mining cost and therefore have an influence on the method selected.

Preliminary Selection of a Bulk Mining Method

Characteristics of orebodies for which block caving, sublevel caving, or longhole sublevel stoping are possible mining methods, are described in Table 1. It is not possible to define all of the characteristics that will determine which mining method will be used, but an attempt is made here to outline some of the most obvious, so that guidance in the preliminary selection of a method will be given. Additional study in the Conceptual or Engineering Study stages of the evaluation may be required before the final choice is made.

ENGINEERING EVALUATION

Following selection of the nominal mining method, the planning procedure continues into the Engineering Evaluation, which consists of three distinct levels of study. These are:

(1) Conceptual Studies

(2) Engineering Studies

(3) Detailed Design

The overall planning model is shown on Figure 1.

The purpose of the Conceptual Study is to assess the physical characteristics and work quantities involved in a number of stoping layouts, ore handling arrangements, equipment types and sizes, mine access locations, and the mine services required for each.

In the Engineering Study, the concepts developed will be modified and finalized. All elements of the project will be detailed, and sizes and locations fixed so that quantities of work can be measured, tabulated, scheduled, and costed. If more than one concept is studied, the results will provide comparative costs which will assist in the selection of one arrangement for detailed design. It should be noted that this arrangement will always be subject to modifications as more information comes to light about the geology and nature of the orebody.

The Detailed Design Stage will provide drawings and specifications for construction and will be scheduled to conform with the requirements of the construction schedule. It will include cost and schedule updates, modifications occasioned by new data, procurement and expediting of equipment, supplies, and contractors, and field inspection of the work.

Considerations in the Conceptual Study Applying to a Longhole Sublevel Mining Method

Mine Access. Mine access by shaft and/or ramp and adit will be considered for all underground mining operations. Terrain will play an important part in this choice. In mountainous areas, horizontal adits may be required to provide access to the orebody, and, in some cases, these will be associated with internal shafts. In areas where surface

relief is low or moderate, an inclined or vertical shaft and/or a vehicle ramp may be required.

For longhole sublevel stoping methods, the key features of the access will be that it permits a moderate to high rate of ore transportation to surface, that openings are large enough for the largest component or unit of equipment to be used, and that adequate ventilation is permitted. A major consideration will be whether to provide vehicular access from surface so that mobile equipment does not have to be dismantled for transportation to the underground workings, or from level to level in the mine.

Generally, there is no major significant factor relating mine access to longhole sublevel stoping, and the foregoing comments will apply to almost all underground mining methods.

Stope and Pillar Layout. Patterns of stopes and pillars must be prepared to match the physical configuration of the orebody. A large variety of possibilities exist depending on this configuration. The selection of stope span between pillars will be guided by geotechnical data and rock mechanics calculations. Overall stope height may be limited by the height of a vertical section through the orebody, but infrequently will exceed 400 feet. In dipping orebodies, the unsupported length of hangingwall along the dip will have a bearing on stope stability and on dilution.

Other factors will come into play in the stoping pattern. One of these will be the decision whether or not to use delayed backfill to assist in the recovery of pillars and support of the walls.

Following a general decision on the stope and pillar pattern, spacing of the sublevels required for blasthole drilling must be determined. Current technology favors the use of large diameter holes drilled by in-the-hole or rotary drills. Long straight holes can be achieved with this equipment, and generally speaking, the longer the blastholes, the lower the stope development cost will be as fewer sublevels will be required. Orebody configurations may however determine that longer holes cannot be used. Irregularities in shape can be a factor. A flat dipping orebody might be mineable by a longhole sublevel method if the vertical thickness is 100 feet or more. Orebodies of narrow width may not be straight or continuous enough to permit use of larger diameter holes. In these cases, sublevels may be 50 feet or less apart and smaller diameter blastholes used.

The number of stopes, their dimensions, and mining sequence must be related to the planned daily tonnage in such a way that production can be met from 60% to 80% of the stopes developed. The remaining stopes will be available to provide mill feed if an unexpected occurrence temporarily puts one of the planned producing stopes out of action. The extra stopes will also provide the mine with some flexibility to maintain a relatively constant grade of ore to the mill.

Extraction System. Extraction of the broken ore from the bottom of the stope must now be planned. The rapidity with which trackless equipment will draw ore when compared to track equipment or slushers may make trackless equipment an obvious choice. Fewer stopes will be needed for production, and the production equipment may be interchangeable with development equipment. Drawpoints must be placed to ensure maximum recovery of broken ore from the stope while, if possible, being in a position to recover ore from future pillar mining.

Ore Handling and Transportation. Ore must be transported from the drawpoints to an orepass or directly to a crusher dump. This will be accomplished if distances are short by frontend loaders or LHD equipment. For longer distances, trucks may be required.

Size of equipment will be determined by balancing capital and operating costs. Larger equipment will require larger openings, both of which will cost more than a system using smaller equipment. However, operating costs with the large equipment will be correspondingly lower than operating costs using small equipment.

A time related comparison considering the total tonnage of ore available and the daily production rates, will provide the basis for an optimization of this equation. A comparison based on preliminary costs in the Conceptual Stage will reduce the number of possibilities that may be carried forward into the Engineering Study Stage of the evaluation.

Crushers, conveyors, and loading pockets will be sized and located in the Conceptual Study. Decisions will be made whether grizzlies and rockbreakers are preferable to underground crushing. Underground storage related to mine and mill operating days per week will be considered and storage bins sized and located.

Provision must be made also for handling waste for mine development. The waste handling system will generally parallel the ore system ending at the mine access so that waste can be hoisted. Options to consider in the planning may be the dumping of waste in empty stopes when these are available, or, if

waste is minimal, truck hauling of waste to surface on a ramp may be preferred.

Mine Services. Provision must be made for pipelines, ventilation, air heating in some cases, electric power distribution, underground and surface maintenance shops, fueling stations, lunch rooms, underground warehousing and parts storage, and a number of other services without which the mine could not function. In the Conceptual Stage, these will be sized and located.

The result of the Conceptual Study will be one or more preliminary schedules, conceptual general arrangement drawings, and a preliminary selection of equipment required. Data will be sufficient to prepare a preliminary tabulation of physical quantities, and order of magnitude costs so that alternatives can be compared and unfavorable alternatives eliminated from further study.

Engineering Study

The Engineering Study is depicted in Figure 2, further expanded in Figures 3, 4, 5, and 6. Alternatives selected from the Conceptual Study for Engineering Study must be tested, modified, and optimized in the Engineering Study Stage so that the final selection for detailed design and construction will provide the one method considered to provide the best profit for the project.

From the general arrangement drawings, the physical quantities that must be scheduled and costed can be measured or calculated, and lists of these items can be prepared.

The stope and pillar layout which will provide tons and grade of ore and a mining sequence will be used to prepare production, drilling, blasting, development, and installation schedules.

Performance calculations will result in unit costs for the activities associated with the elements of these schedules. When these activities are broken down to equipment, labour, supplies, materials, and other costs, unit costs can be calculated and applied to the items described in the schedules for each month, quarter, or year.

The result of this tabulation will be a cost schedule which can show the capital and operating costs for the project and will define costs planned prior to the start of production and costs planned after the start of production.

The former will determine the capital investment required, and the latter, when deducted from the expected income from the product, will determine the rate of repayment and return on the investment.

The final result of this study will be a report which will be the basis for a decision to proceed with the project. The report will be used to obtain project financing.

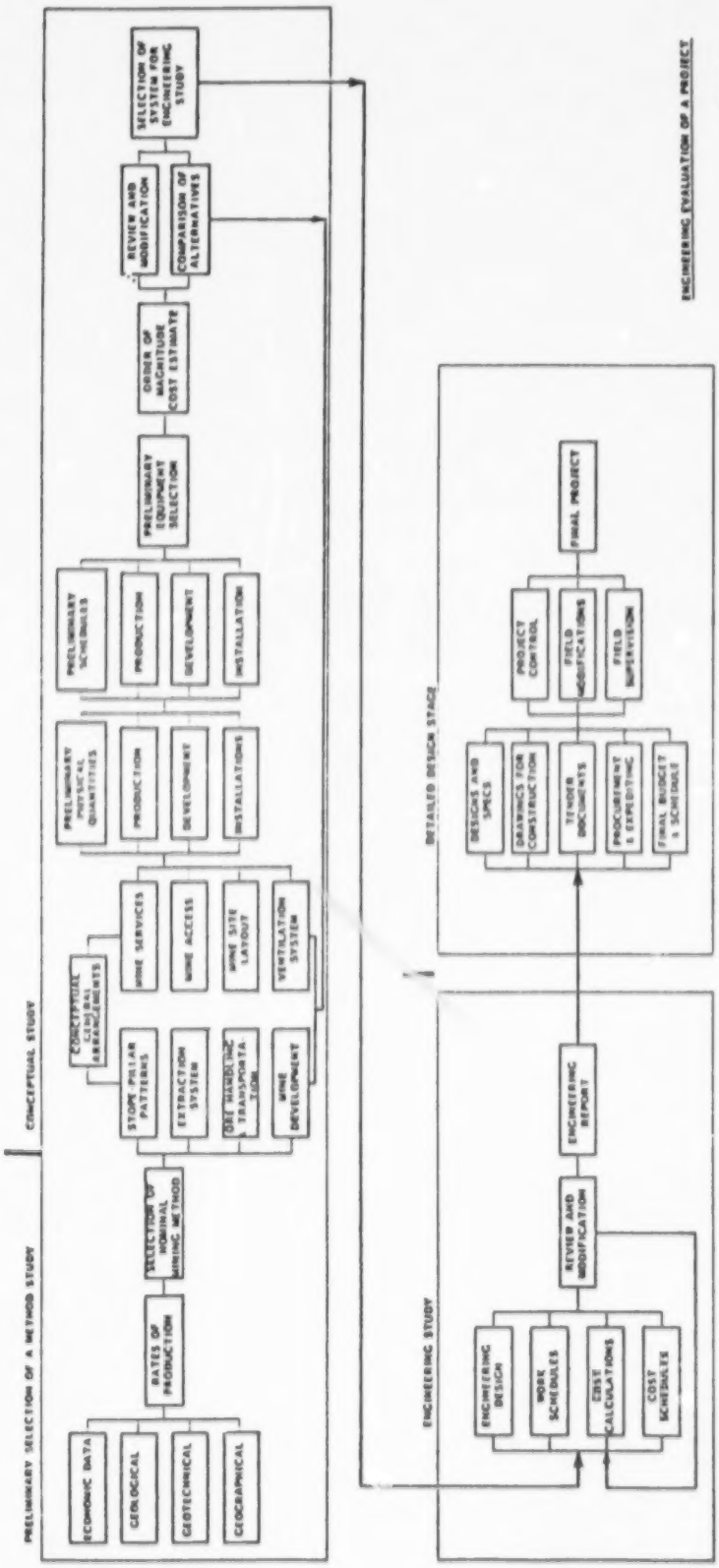
Detailed Design

One plan of action will be progressed forward to the Detailed Design Stage. It will be subject to modification as the design proceeds and additional information comes to light, but it will generally follow the plan defined in the Engineering Study. There will be a period of time after the completion of the Engineering Study during which the report will be reviewed and analyzed, risks evaluated, and financing obtained. During this period, some detailed design work may be carried on so that when the decision is made to proceed, there will be no delay in getting work started. If long delivery items are identified as being critical to meeting production dates, orders with cancellation provisions may be negotiated to protect these critical dates. Preparation of key tender documents and prequalification of contractors may also be carried out. A team of design personnel will work to a schedule defined by the construction schedule for the project. Drawings may be modified in the field by site engineers if conditions change or were not fully defined in the office.

Generally, the sequence of events for the Detailed Design Stage will be defined by the project critical path schedule and no attempt to illustrate this has been made in this paper.

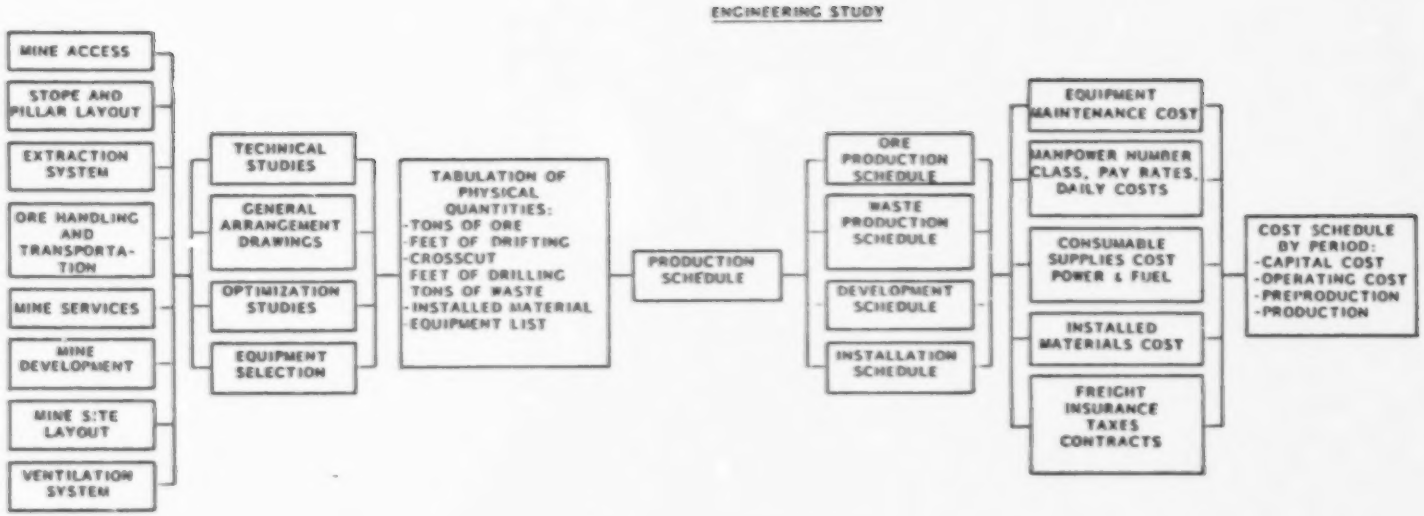
CONCLUSION

A series of well defined steps can be illustrated by a planning model to progress from geological, geographical, geotechnical, and economic data for an orebody to a final engineering report on which investment decisions can be made. The model expresses the elements of the study in basic terms that can be used to promote a clearer understanding of the meaning of these terms when defining the level of engineering study to be undertaken. The model has been developed in association with a basic discussion of the selection of a longhole sublevel mining method, but with slight modification, can apply equally to other methods.



ENGINEERING EVALUATION OF A PROJECT

FIGURE 1



ENGINEERING DESIGN	WORK SCHEDULES	COST ESTIMATES	COST SCHEDULE
ONE OR MORE CONCEPTS REDUCED TO A TABULATION OF PHYSICAL QUANTITIES OF ORE, WASTE, DEVELOPMENT, ETC., FOR SCHEDULING AND COSTING. PHYSICAL COMPARISONS MAY LEAD TO REJECTION OF SOME CONCEPTS BEFORE COSTING IS DONE.	TONS OF ORE AND GRADE BY STOPE, PILLAR OR BENCH, AND BY TIME PERIOD REVENUE BY TIME PERIOD IDENTIFICATION OF KEY DATES: -PRODUCTION START-UP -EQUIPMENT DELIVERIES PERFORMANCE CALCULATIONS: -SEE EXAMPLES -FIGURE 3 - DEVELOPMENT -FIGURE 4 - BLASTHOLE DRILLING -FIGURE 5 - BLASTHOLE LOADING -FIGURE 6 - INSTALLATION	COSTS FOR EXPENSE ITEMS DAILY COST EXPANDED TO MONTH AND YEAR	OVERALL SUMMARY OF PROJECT FOR FINANCIAL EVALUATION

FIGURE 2

DEVELOPMENT AND EXCAVATION PERFORMANCE

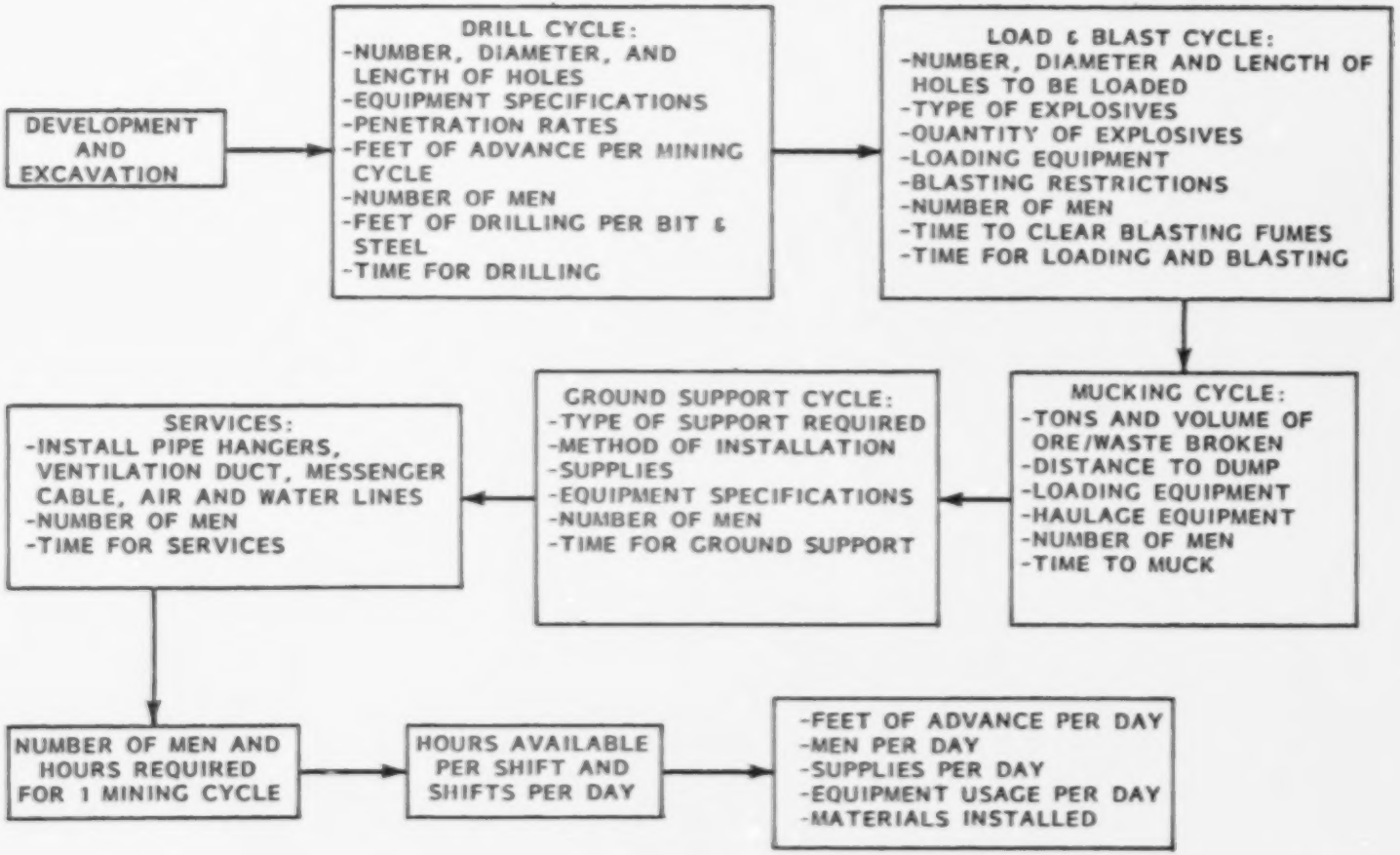


FIGURE 3

BLASTHOLE DRILLING PERFORMANCE

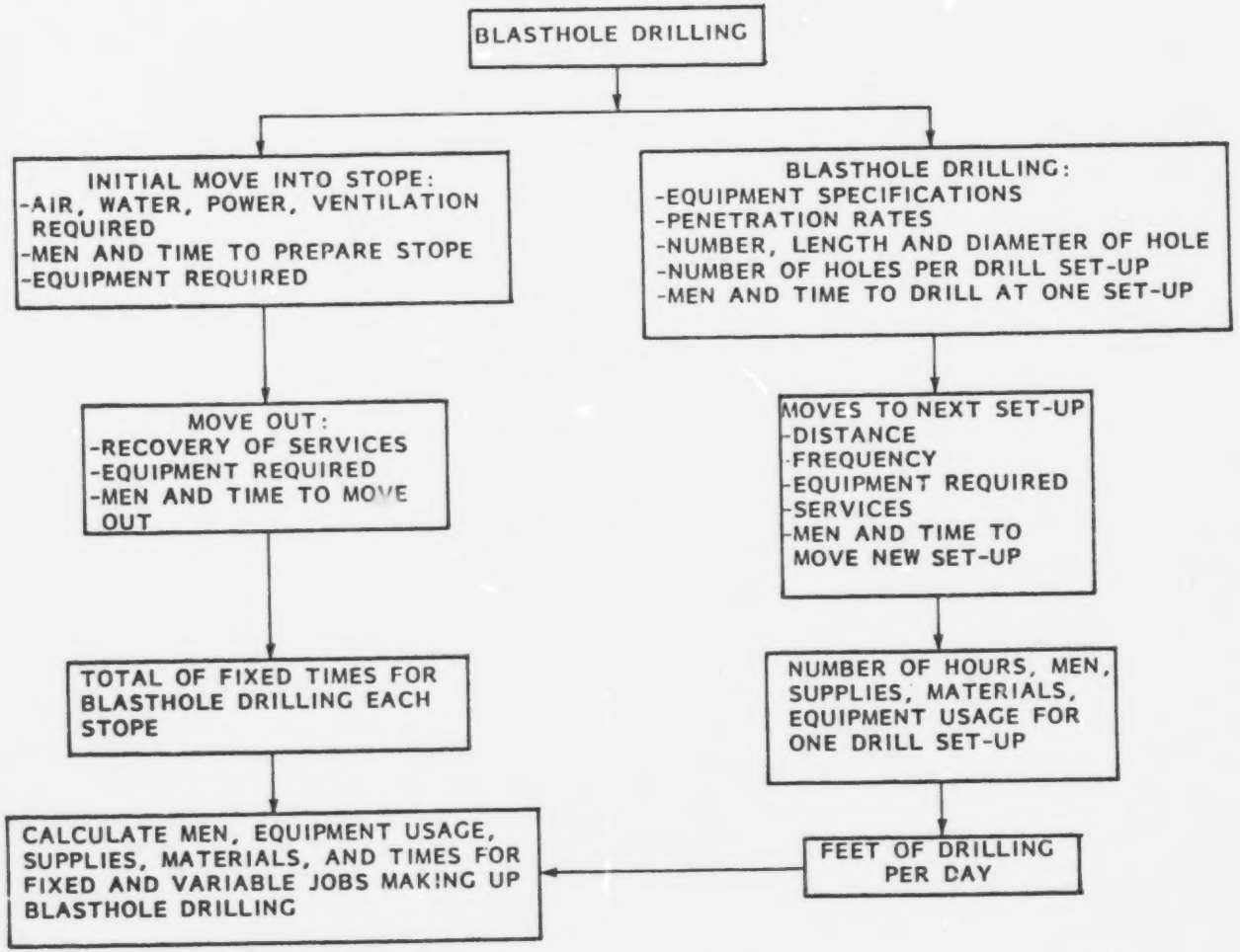

BLASTHOLE DRILLING
INITIAL MOVE INTO STOPE:
-AIR, WATER, POWER, VENTILATION REQUIRED
-MEN AND TIME TO PREPARE STOPE
-EQUIPMENT REQUIRED
BLASTHOLE DRILLING:
-EQUIPMENT SPECIFICATIONS
-PENETRATION RATES
-NUMBER, LENGTH AND DIAMETER OF HOLE
-NUMBER OF HOLES PER DRILL SET-UP
-MEN AND TIME TO DRILL AT ONE SET-UP
MOVE OUT:
-RECOVERY OF SERVICES
-EQUIPMENT REQUIRED
-MEN AND TIME TO MOVE OUT
MOVES TO NEXT SET-UP
-DISTANCE
-FREQUENCY
-EQUIPMENT REQUIRED
-SERVICES
-MEN AND TIME TO MOVE NEW SET-UP
TOTAL OF FIXED TIMES FOR BLASTHOLE DRILLING EACH STOPE
NUMBER OF HOURS, MEN, SUPPLIES, MATERIALS, EQUIPMENT USAGE FOR ONE DRILL SET-UP
CALCULATE MEN, EQUIPMENT USAGE, SUPPLIES, MATERIALS, AND TIMES FOR FIXED AND VARIABLE JOBS MAKING UP BLASTHOLE DRILLING
FEET OF DRILLING PER DAY

FIGURE 4

BLASTHOLE LOADING PERFORMANCE

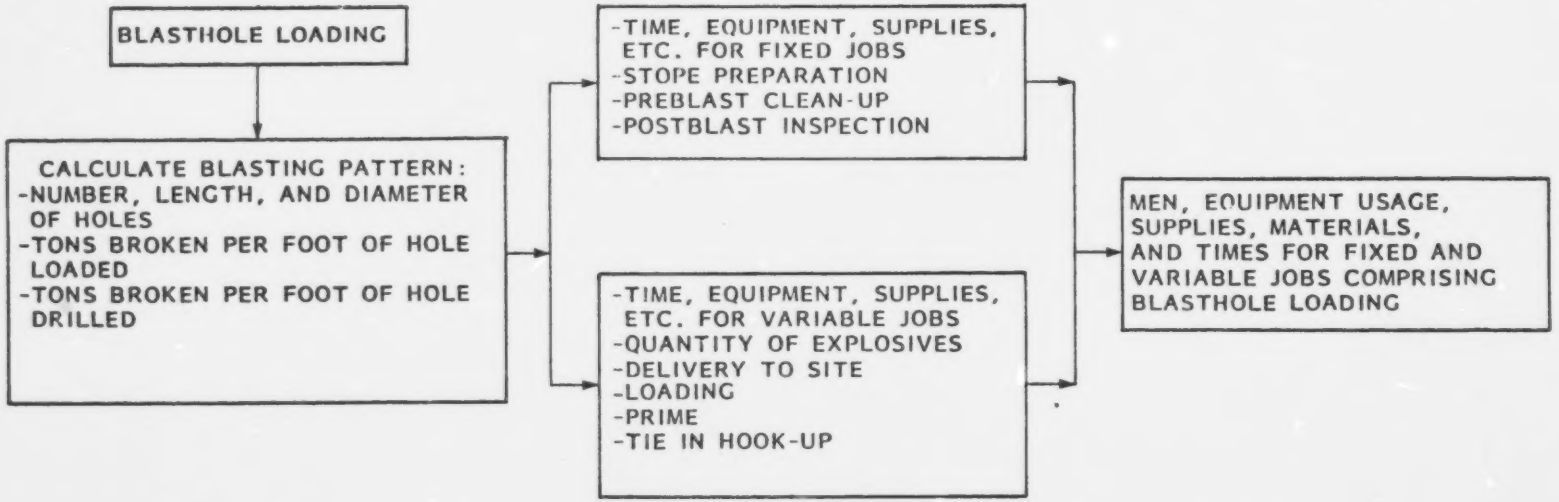

BLASTHOLE LOADING
CALCULATE BLASTING PATTERN:
-NUMBER, LENGTH, AND DIAMETER OF HOLES
-TONS BROKEN PER FOOT OF HOLE LOADED
-TONS BROKEN PER FOOT OF HOLE DRILLED
-TIME, EQUIPMENT, SUPPLIES, ETC. FOR FIXED JOBS
-STOPE PREPARATION
-PREBLAST CLEAN-UP
-POSTBLAST INSPECTION
-TIME, EQUIPMENT, SUPPLIES, ETC. FOR VARIABLE JOBS
-QUANTITY OF EXPLOSIVES
-DELIVERY TO SITE
-LOADING
-PRIME
-TIE IN HOOK-UP
MEN, EQUIPMENT USAGE, SUPPLIES, MATERIALS, AND TIMES FOR FIXED AND VARIABLE JOBS COMPRISING BLASTHOLE LOADING

FIGURE 5

INSTALLATION PERFORMANCE

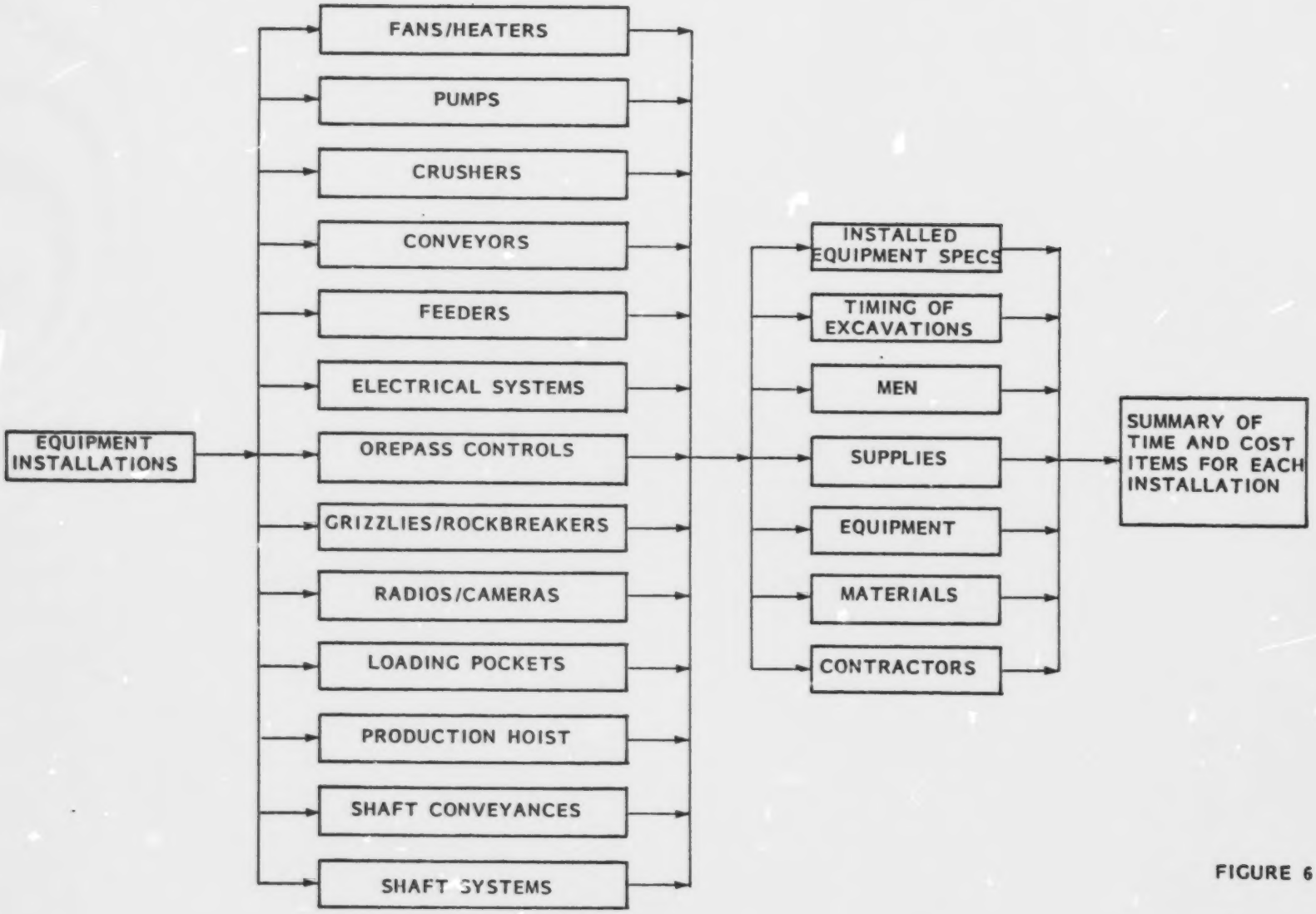


FIGURE 6

Development Role of the Mining Contractor in Terms of Organization, Philosophy, Technology and Execution.

A. D. McCutcheon, President
Canadian Mine Services Ltd.
Vancouver, British Columbia

April 28th, 1976

Abstract

Historically the mining contractor has provided service to mining companies to execute initial exploration and development programs, or to supplement in house capacity in periods of peak activity.

More recently, with the ever increasing complexity of technology, and rapid advance of mechanization into widespread areas and with the attendant problems of providing the necessary specialized equipment and personnel, the contractor's role has been extended to other functions. This now includes training, and the development not only of specialized mining techniques, but the integration of equipment design and construction with specific operational requirements.

The historical function of course still constitutes the prime reason for the contractor's existence. However, a progressively more technical involvement is resulting in a broader contract base of integrated activities with resulting benefits of stability, improved application and efficiency.

Introduction

Practically all mining companies at one time or another employ a mining contractor, who by providing specialized technology, equipment and personnel, offers an economic solution to the company's problems during periods of peak activity, in remote areas, or under special conditions.

Such a determination when based upon proper consideration of all the pertinent factors should be advantageous to both the owner and the contractor. The owner should realize his objective of having the work done at the lowest cost, in the shortest time and in the best manner: and the contractor should realize a profit.

Within such a context, the contractor's role in the industry is justified. However, it is important to consider some of the prerequisites for successful contracting.

Development of Contractual Relationship

The form of contract to be used is of prime importance since it is the base for a constructive and co-operative relationship between the parties.

When there is sufficient time to define the conditions, develop specifications, solicit and evaluate formal bids, the owner's interests may best be served by a firm-fixed-price type of contract, which in effect guarantees the final cost and time of completion. The contractor takes all the risks but is motivated by competitive bidding to perform with maximum efficiency.

Conversely, the extent to which conditions and specifications are not defined and are indeterminate will establish the extent to which the contract departs from the firm-fixed-price concept and approaches the least formal arrangement. All risk is for the owner's account, the realization of whose objective is dependent more on the contractor's cabability and integrity than on a formal contractual relationship. Between the two extremes there are of course a number of variations which provide for flexibility in work quantities and terms, revision of prices based on specific conditions, sharing of risks, establishing a contractor's fee, etc.

In the case of a firm-fixed-price type of contract, the owner will generally solicit formal bids from an indefinite number of contractors, or in some cases from a restricted number who are known to have the necessary qualifications. The terms of the contract are formal, reflecting little or no input from competing contractors. Under appropriate conditions it can be in the best interests of both parties.

However, there are some disadvantages. From the contractor's point of view requirements for bonding, insurance, hold back and other standard conditions may be too restrictive and cause unecessary expense.

In situations requiring a less formal contract as is most often the case in the mining industry, the development of contract terms, although essentially the owner's function, is an area in which competing contractors have a significant input. The final contractual basis evolves during the process of soliciting bids, evaluating contractors proposals and finally in direct negotiation with the selected candidate. Based upon the premise that the informal mining contract is the rule rather than the exception, it is an interesting and challenging prospect. Not only does it stimulate the development of original concepts and progessive techniques, but it enables the contractor to participate in the formulation of conditions best suited to efficient and successful operation.

However, one might adopt the opposite point of view and maintain that the owner does in fact determine the terms of the contract in total with little or no input from contractors. This of course is true in relation to more formal contracts as previously stated, but if applied too arbitrarily to less defined cases it may result in terms and conditions inappropriate to the job and so jeopardize the outcome. This is one of the pitfalls in contracting which both parties would want to avoid.

The foregoing outlines the conditions and procedures pertinent to the development of a constructive contractual relationship. Attention can now be directed to the mining contractor per se, and to his role in the execution of the work program.

Role of the Mining Contractor

Successful mining contractors have certain common qualities. They all have a satisfactory record of performance based on management ability, organizational structure, skilled personnel, specialized equipment, financial competence, etc. Operating often in remote areas and under difficult circumstances, they are flexible and ingenious in the development and transfer of mining technology. Being on the whole products of the mining industry, they are responsive to the company's requirements, trying to do the job at least cost, in the best manner and in the shortest time. They are motivated by their mining identity, pride in their reputation, and pride in accomplishment. They are also motivated by the profit potential, which is necessary to develop the type of contracting organization required in the industry.

Such is the character of mine contractors in general. However, there is another facet to their character: the great diversity in special aptitudes, functions, contracting philosophy, informal relationships and personalities etc., which result in widespread geographic and technical diversification. Herein lies their strength and their benefit to the mining industry which could be comprehensively described only by a documentation of all mine contracting activity.

This obviously is not feasible. However, some aspects of the contractor's role may be appreciated by referring directly to current activities of a specific contractor. The examples cited have been chosen primarily to emphasize the diversification of contract functions within the industry.

EXAMPLES OF CURRENT CONTRACT PRACTICE

Canadian Mine Services Ltd.

Since incorporation in 1963, in Vancouver, British Columbia, the company has specialized in underground mine development and surface and underground diamond drilling. It has operated in eight of the Canadian provinces and territories, several of the United States, and overseas in Ireland. Geographic expansion has been accompanied by a progressively increasing volume of activity and the strengthening of internal technical support facilities.

The company has been active in the development of equipment and technology to promote operational efficiency and to maintain a competitive position. An effort has been made to develop a balanced organization designed for stability and self sufficiency within specialized mining and diamond drilling functions.

Equipment Development and Application

Efforts in this area are directed to new concepts and designs for direct application in mine contract activities. Close liaison between development construction and operation personnel is maintained to ensure that the end product conforms with performance and serviceability requirements. Equipment components used in construction are of proven quality, mass produced and widely distributed.

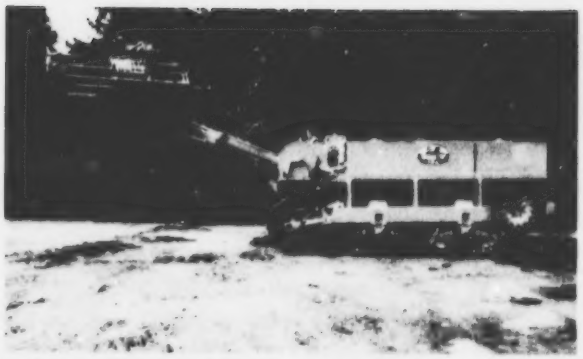


FIGURE 1

Figure 1 shows an early model of "Superdrill", originally conceived in 1971. It is a mobile high performance underground diamond drill, either diesel or electric powered. All operating components, (head, feed, rod breaker, rod holding assembly, stabilizer, water pumps, wireline hoist etc.,) are hydraulically driven. The head is mounted at the end of a boom, on a mobile carrier. carrier.

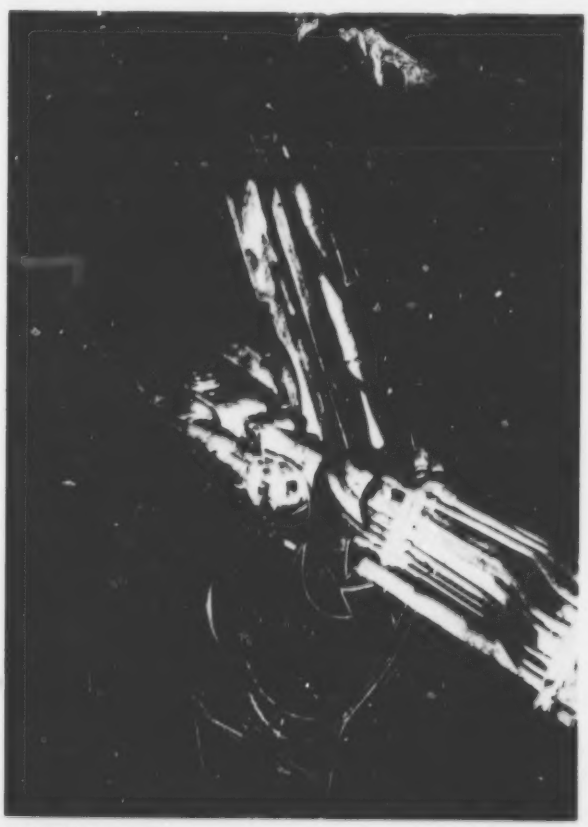


FIGURE 2

Figure 2 shows the drill positioned for drilling upward, which is easily accomplished compared with the elaborate staging required for conventional equipment. In the situation illustrated, operating in a 16 foot high tunnel, a 16,000 foot contract was completed at an average productivity of 84 feet per drill shift, compared to 45 feet for conventional equipment, prior contract, same location.

FIGURE 3

Figure 3 shows an arrangement of Superdrill II, electric powered, for operation in a track mine. The hydraulic boom is designed to position the head for drilling at virtually any angle.

FIGURE 4

Figure 4 shows the same machine drilling upward in a concrete lined drift 9 feet high. A contract of 18,000 feet in highly fractured rock was completed at an average of 60 feet per drill shift, which is 3 times the rate for previously engaged equipment.

FIGURE 5

Figure 5 shows a skid mounted electric Superdrill and its operating consol, designed for use in small headings.

OPERATIONAL DATA WHICH HIGHLIGHTS SUPERDRILL PERFORMANCE CAPABILITY.

240 FEET — 8 HOUR SHIFT
650 FEET — 7-8 HOUR SHIFT
410 FEET — 24 HOURS
3,135 FEET — HALF MONTH
5,825 FEET — CALENDAR MONTH
180 FEET — 8 HOURS VERTICAL HOLE
120 FEET — 5 MOVES & SET-UPS 8 HOURS

FIGURE 6

Figure 6 shows data extracted from recent drilling contracts, indicating the performance capability of Superdrill under different conditions.

Performance of any particular drill will of course vary widely under different drilling conditions. However, experience with Superdrill indicates a relative advantage of 2 to 3 times the rate for conventional equipment. It is a highly specialized machine, designed for use where a large volume of drilling is required in a short period of time, and in situations where underground development and diamond drilling are done concurrently. Its basic characteristics, (mobility, optional diesel or electric powered hydraulic systems), facilitate integration with tunnelling equipment including the hydraulic percussion drill jumbos which are coming into common use. Somewhat similar hydraulic technology applied to both machines simplifies maintenance procedures.

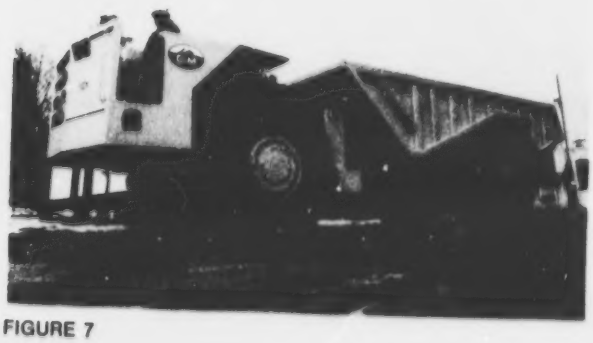


FIGURE 7

Figure 7 shows a 40 ton capacity low profile 4 wheel drive truck. This is an example of the use of mass produced universally distributed power train components used in the manufacturing of a specialized underground haulage vehicle. The engine, wheels, front and rear axles are standard components for the Caterpillar 988 wheel loader. Torque converter and transmission are standard components for the Caterpillar 825 B compactor. Other basic items such as controls, instruments and engine driven pumps, are also Caterpillar products. The frame, box and dumping mechanism are designed to match the operational characteristics of the power train and to satisfy the required performance specifications.

FIGURE 8

Figure 8 shows the first unit upon arrival at the mine site for use in contracting. Elapsed time from conception to commencement of operation is just over 8 months, which illustrates the capability for custom underground equipment building within a contractor's closed circuit of design-construct-operate.

Primary Mine Exploration and Development

FIGURE 9

Figure 9 shows the portal site for an exploration decline on the Kerr Addison—AEX Syndicate joint venture—Grum project, in the Yukon. The photograph was taken during a field survey early in January 1975.

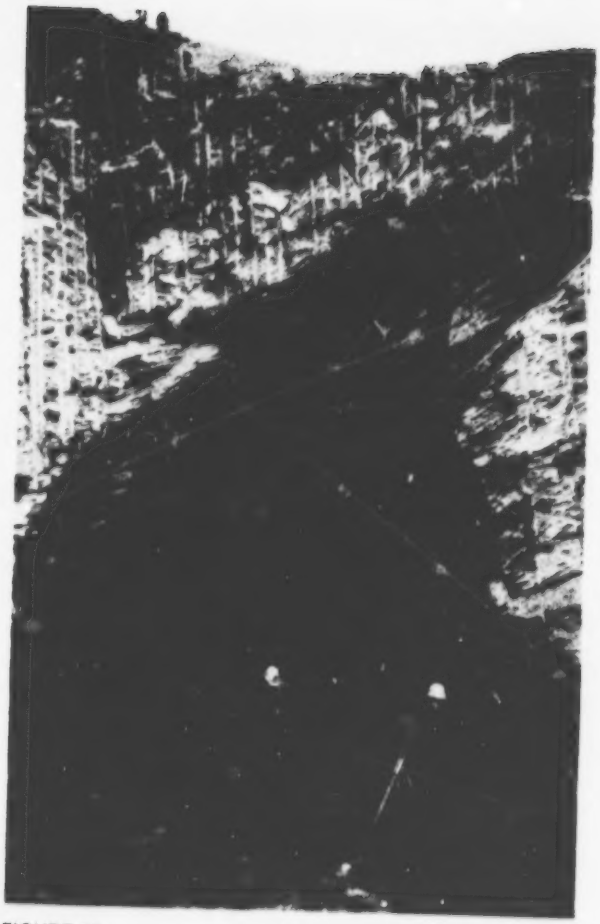


FIGURE 10

Throughout the month, working in liaison with the client, plans were developed for the program which was to consist of 8,600 feet of exploration and 60,000 feet of surface and underground diamond drilling. In addition, plans and specifications were prepared for surface facilities required to support the program. This included a 90 man camp complete with fresh water well, sewage and septic field, and a 5,000 square foot shop, complete with 4—250 KVA electric generators and 3—630 CFM stationary electric compressors. The entire camp and plant were winterized and built for year round operation.

At the end of January, a proposal was submitted to the client, final details were worked out during February and the project was released for action.

During March, roads were opened, the site was cleared, temporary camp and shop facilities were erected, the decline route was test drilled, overburden and rock were excavated to establish the portal, as shown in Figure 10.

FIGURE 11

During April, an 18 foot diameter steel supporting structure was installed from surface down the decline trench and beyond the rock brow (Figures 11, and 12, and 13) and backfilled with excavated material. Permanent camp and plant were constructed, services for sewage, water and power were installed. Diamond drilling and tunnelling equipment were moved on site and by month end the decline was advancing and diamond drilling was underway, on a unit price contract basis and on schedule.

Although the project has many interesting technical features, it is not the purpose of this presentation to deal with such in detail but rather to use the circumstances pertaining to the job to illustrate certain aspects of the contractor's role in the mining industry.

Timing was a critical factor. The client's decision to proceed with the 1975 program was triggered by 1974 surface exploratory drilling from which some significant results were not available until late in the year. Consequently, there was insufficient time for the development of detailed plans and specifications and to make the necessary internal arrangements for the scale of project contemplated, thus setting the stage for a contractual undertaking.

FIGURE 12

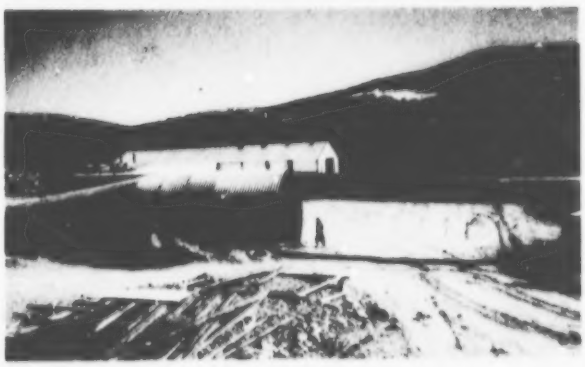


FIGURE 13

The contractor was able to respond to the job requirements in a number of ways. By working closely with the client, exploration and diamond drilling plans and schedules were prepared, together with the necessary plans and specifications for surface support facilities.

All the necessary skilled personnel, excavation and drilling equipment were immediately available from within the same general geographic area.

The contractor had extensive experience in the immediate job environment, in addition to general mining and diamond drilling contract experience. This was reflected in the preparation of the work site, excavation of the portal trench and installation of the steel structure, all within a period of two months. Key factors were as follows:

(a.) Overburden from the portal trench was excavated during winter conditions precluding any possibility of side slope instability, which can be a critical factor in the glacial clays of the area. This was carried out using temporary camp and mobile plant facilities.

(b.) The installation of an 18 foot diameter steel liner through the portal and subsequent backfilling established a permanent structure through the unstable overburden.

c.) Rock excavated from portal preparation was used to surface the plant site prior to spring break-up, establishing a stable bed which would otherwise have been a quagmire.

Training of Mining Crews

Frequently a mining contractor can play a useful role in training personnel, particularly where mining operations are relatively new. Tara Mines in Ireland is such an example, where there is an exceptionally good and abundant source of trainee candidates.

The Tara program is planned to provide a mining crew entirely from the local population, within the pre-production development period. The incumbent contractor (C.M.S. Ireland Ltd.), with a group of 8 Canadian instructors, following a comprehensive training manual are inducting 8 trainees per month. Instruction consists of initial class room lectures and general orientation, familiarization with and operation of mining equipment on surface, followed by introduction to the underground environment and instruction in equipment operation.
Each trainee is rated for aptitude and progress on a weekly basis. To date a high percentage of the candidates have completed their course and are employed in the mine. After the 4 month training program, productivity per man is about 75% of that for the regular development crew. Reasons for the success are related to the careful selection of candidates from the considerable number of local applicants, careful planning by the mine management and the constructive attitude of the Irish trainees.

Conclusion

Fundamentally there are two conditions required for successful mine contracting:

1. Circumstances must be such that it is in the owner's interest to consider contracting.
2. The contractural relationship must be appropriate for the job conditions.

The contractor's success is dependent upon his capacity for competitive performance, without which he cannot survive. It is also dependent upon his management and administrative capacity to help develop and maintain the conditions essential to the success of the undertaking. Both are functions of all his personnel in terms of their principles, personalities, aspirations, motivation etc.

Hopefully this presentation has contributed to an understanding and appreciation of the mine contractor's role in the industry, in the context of circumstances which warrant contracting and under a relationship conducive to good contracting and good results.

In closing I would like to express my appreciation and gratitude to the many mining organizations and mining people with whom I have had the privilege of associating over the years, and in particular to those with which Canadian Mine Services has worked.

CIM UNDERGROUND OPERATORS CONFERENCE

FEBRUARY 15-18, 1981

SUDBURY, ONT.

TITLE: APPLICATIONS FOR ONE BOOM HYDRAULIC JUMBO

AUTHOR: J. R. Wright

Senior Mining Engineer

CANADIAN MINE SERVICES LTD.

ABSTRACT:

APPLICATIONS FOR ONE-BOOM HYDRAULIC JUMBO

This paper will discuss the application of the one boom hydraulic drill jumbo in drifting and stoping. Also the choice of either a diesel or electrical power package will be evaluated. Operating factors such as heading location, power source, heading size and configuration, and number of active faces available will be considered as they effect the selection of the one-boom hydraulic drill jumbo.

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FIFTH ANNUAL UNDERGROUND OPERATORS CONFERENCE

February
16-18, 1981
Sudbury

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Program Chairmen: B. Nicholson, Inco Metal Company; L. Rajala, Falconbridge Nickel Mines Limited

PAPER: 2

SESSION: MINE DEVELOPMENT

TITLE: APPLICATIONS FOR ONE-BOOM HYDRAULIC JUMBO

AUTHOR: J.R. WRIGHT
CANADIAN MINE SERVICES LIMITED

John R. Wright

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John Wright graduated in Mining Engineering from Queen's University in 1970. He gained experience as a shiftboss, planning engineer, and mine engineer, working for Sherritt Gordon Mines Ltd., at Lynn Lake, Manitoba and with Cominco at the Con Mine in Yellowknife, N.W.T. He joined Canadian Mine Services Ltd. in 1977 as Project Engineer at the Denison Project, Elliot Lake, Ontario where he supervised C.M.S.'s on-site engineering group. Mr. Wright moved to Assistant Project Manager at Denison in 1978. In late 1979, he moved to the CM Group's head office in Brampton, Ontario where he is currently involved in contract bidding and administration of mining projects for Canadian Operations. Mr. Wright is a registered professional engineer in the provinces of Ontario and Alberta.

APPLICATIONS FOR ONE-BOOM HYDRAULIC JUMBO

INTRODUCTION

In the late 1970's, with the introduction of hydraulic drills, the mining industry's approach to multi-boom drill jumbos changed. Traditionally with air jumbos the trend had been to add additional drills to a jumbo without increasing the face crew. With air jumbos, one man for two drills was the rule. Because of the more than double penetration rates of the hydraulic drill, it was found that one man per drill was required if a hydraulic jumbo was to be operated at top efficiency.

Another major difference between air and hydraulic jumbo is the capital cost of the unit. With an air jumbo the addition of a 2nd boom and drill only increases the unit cost 20 to 25% while an additional boom and drill on a hydraulic jumbo increases the cost about 75%. Thus the capital cost of two single boom hydraulic jumbos is only 10 to 15% above the cost of similar two boom hydraulic jumbo. In many situations this additional cost is justified because of the additional flexibility provided by two independent jumbos.

For the above reasons, the development and building of one boom hydraulic drill jumbos appeared both practical and economical. The next step was to evaluate the areas where a single boom unit was applicable. The use of a one boom unit for a single drift heading only is not feasible since the longer drill cycle time would only slow down the heading and result in a higher cost for the drift since all other equipment is sitting idle for longer periods. Thus the operating criteria for employing single boom jumbos was based on multiple headings.

OPERATING CRITERIA

The initial factor to be considered was the heading size. When driving a drift with a jumbo there is approximately 30 to 45 minutes required in the drill cycle time to allow for moving in a jumbo, setting up, and for moving out regardless of the size of the jumbo. This moving time combined with a penetration rate of 4 to 5 feet per minute allows for drilling up to 50 - 11 foot holes in approximately 3 hours. The minimum size was dictated by the existing mucking equipment, mining regulations requiring minimum drift clearances, and the amount of ventilation required at face. Thus the heading size considered practical for a one boom unit was from 80 sq. feet (8' x 10') to 160 sq. ft. (10' x 16'). With this size range the drill unit would have the capacity to drill two 11' rounds per 8 hour shift.

Since the size of heading best suited to this unit would not always be available, the jumbo was equipped with a boom that was capable of drilling in all directions. With this flexibility the unit could be used for such work as drilling longwall slashes, and drilling down for benching.

When designing the one boom jumbo it was decided to build a carrier that could operate with either an electric or diesel power package. In an existing area where electrical power was readily available the unit is equipped with a small diesel engine (65 HP) for transporting the drill and with a 60 HP electric motor for powering the hydraulic package when drilling. In remote locations where power is only available from diesel generators which would have to be installed to operate the jumbo, a larger diesel engine (120 HP) is installed on the jumbo. This engine is capable of powering the hydraulic package and is compatible with the engine of the LHD units (3½ yd.), normally used with this jumbo. Therefore, additional

ventilation is not required to operate this unit. Another major advantage to the diesel package in remote locations is that the jumbo may be used the day it arrives on site for collaring portals to 40 ft. while the support facilities are being set up. Also eliminated is the installation and maintenance of the electrical power distribution system to the jumbo. The equivalent drill capacity in an air jumbo (3 boom) would require three 600 CFM compressors.

Three examples where the single boom hydraulic jumbo has proven successful over the past two years are: in small multiple headings as shown in Figure I, large low profile headings as in Figure III, and in a remote northern location driving 9 x 13 drifts. In each case a minimum of three faces per jumbo were being driven.

8' x 16' Drift

Figure I illustrates the drift configuration for which the one boom jumbo was first used. This drift X-Section was driven in an 8' high ore zone with minimum dilution. The drill hole pattern shown in Figure I indicates that depending on the location of the cut holes, up to 65% of the drilling can be on one side of the drill centerline. Thus a two boom unit would not be efficient. Once these headings were complete, the next stage was to excavate a 9' wall slash as shown in Figure II. Because the jumbo was capable of drilling at right angles, this slash was completely pre-drilled with long holes using the one boom unit and blasted later as required for production. This slash was used as a spare face for the jumbo to drill on if circumstances were such that a face was unavailable for drilling.

7' x 30' Drift

Figure II shows a 7' x 30' drift that was driven employing two one-boom jumbos on the face. With this drift layout one side of the face always has more drilling depending upon which side the cut is on for that particular round. Thus one drill will complete drilling earlier and is moved to the next face where it begins drilling on the side with the cut. Thus the idle time for each drill is reduced compared to using a two-boom hydraulic unit in this drift. Since this was a multiple heading situation a third one-boom unit was kept as a spare for the two operating units. The capital cost of these three units was 25% less than the cost of two two-boom hydraulic units which would be required to provide the same availability.

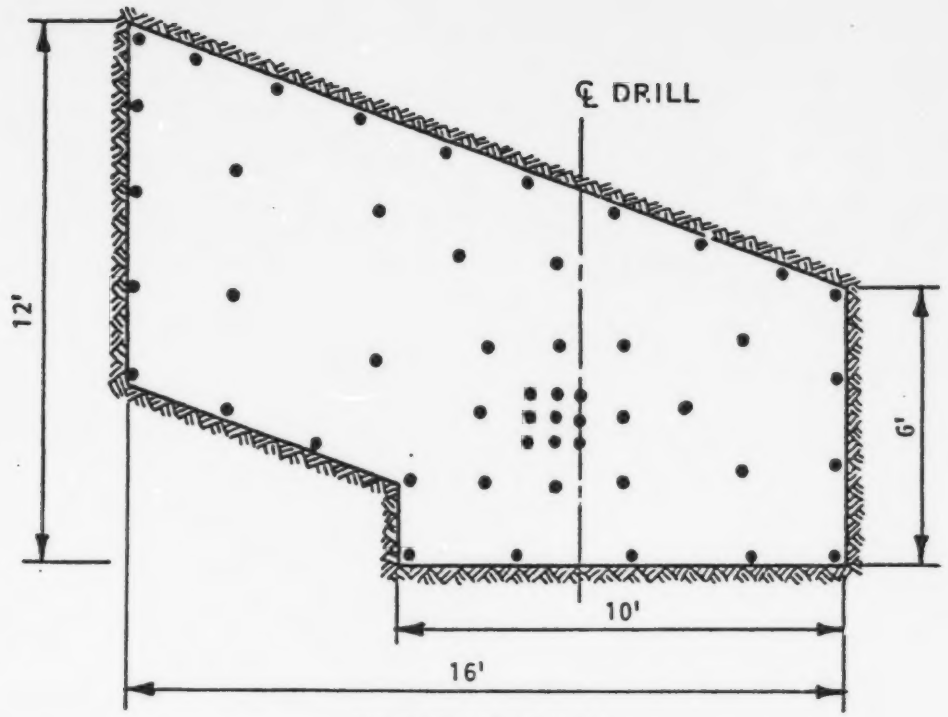
9' x 13' Drift

During the summer of 1980, the one boom jumbos were used to drive ± 7000 ft. of an access tunnel in a very remote location. Figure IV illustrates the tunnel layout and the three access portals by which the tunnel was driven. For this work two one-boom hydraulic jumbos with diesel power packages were employed. Mucking was done with 3½ yd. LHD units. All facilities set up for this work were temporary and were removed at the completion of the tunnel. Thus, by using the diesel package on the jumbo, only a small generator to operate the ventilation fan was required at each portal. Also only a 250 CFM compressor was provided for rockbolting at each location. The ventilation requirements were the same since the LHD unit and jumbo had the same size engine. The diesel jumbos allowed the first 40' of each portal to be driven while the generators and compressors were being set. In fact the first round was being drilled on within 4 nours of the arrival of the first transport trucks on site.

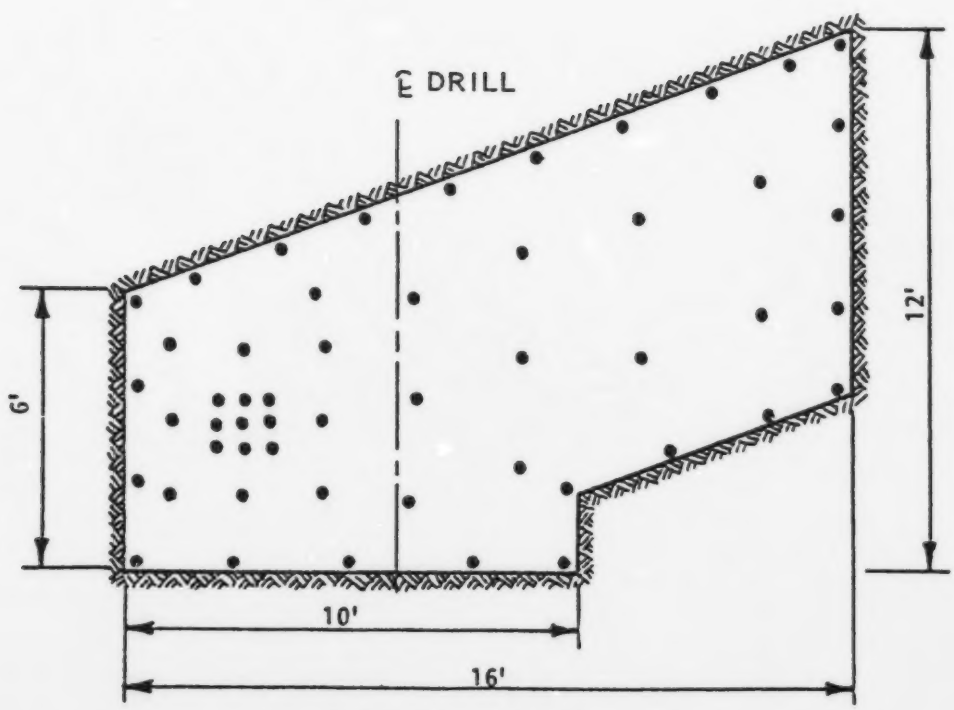
The jumbo's were capable of drilling up to two rounds per shift depending on the length of the move between faces. The entire project time on this tunnel was 3 months for a total of 7000 ft. A mining crew of 5 men per shift averaged 85 ft. per day on 3 shifts for the last two months of the project. Advance for the initial month was restricted because of the number faces was initially only three and steel sets had to be installed at each portal.

CONCLUSIONS

Our experience to date has more than justified the development of one boom hydraulic drill jumbos. The drill operators have accepted these units and have helped us prove that there is a definite place in mining for this unit. The next step is to design both mucking and rockbolting equipment that can complement this drill in small headings and thus gain full advantage of this step forward in mining equipment.



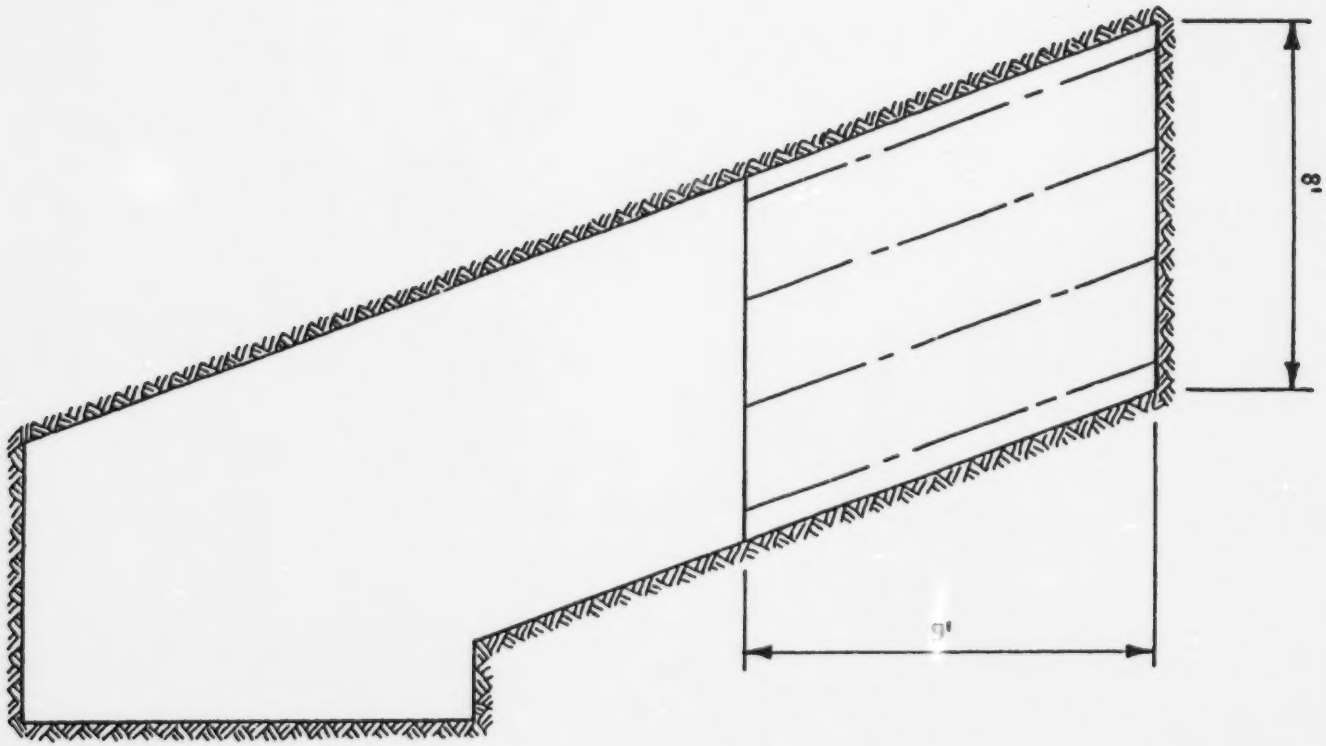
UP DIP HEADING



DOWN DIP HEADING

8' x 16' DRIFT CROSS SECTION

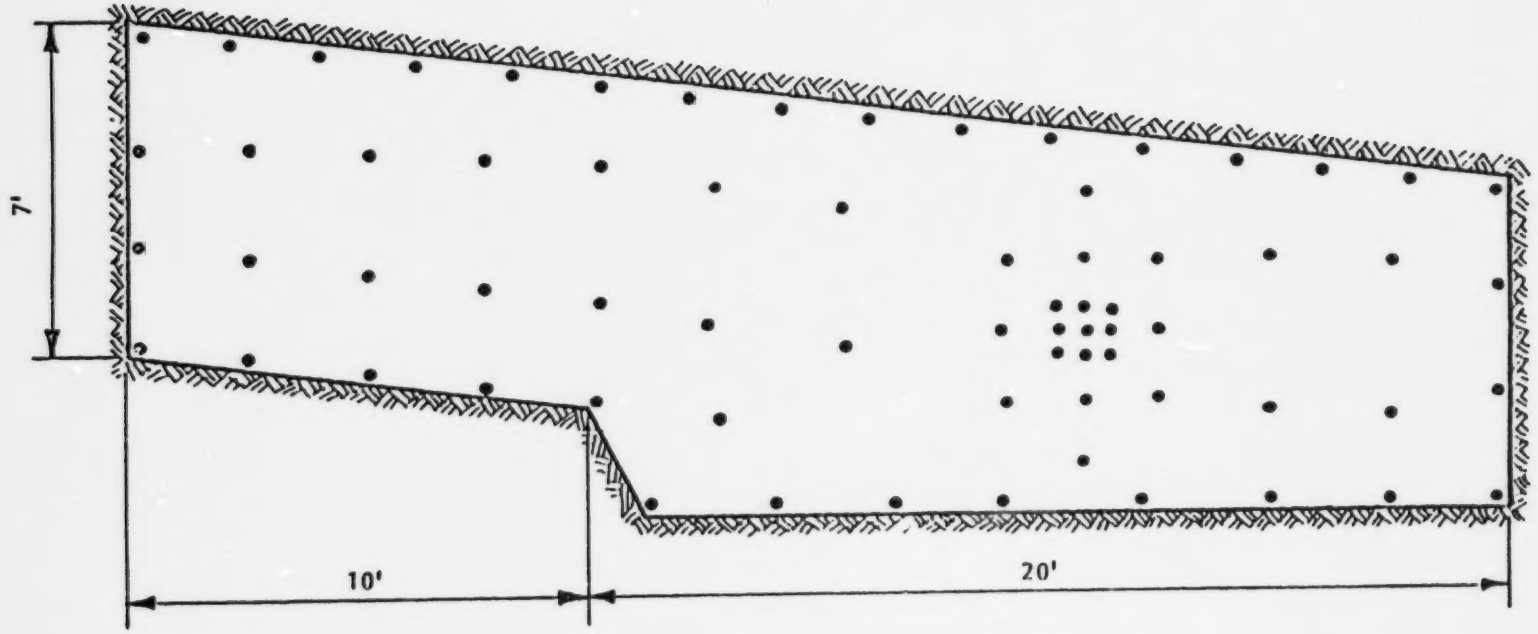
FIGURE 1



WALL SLASH - 8' THICK OREZONE

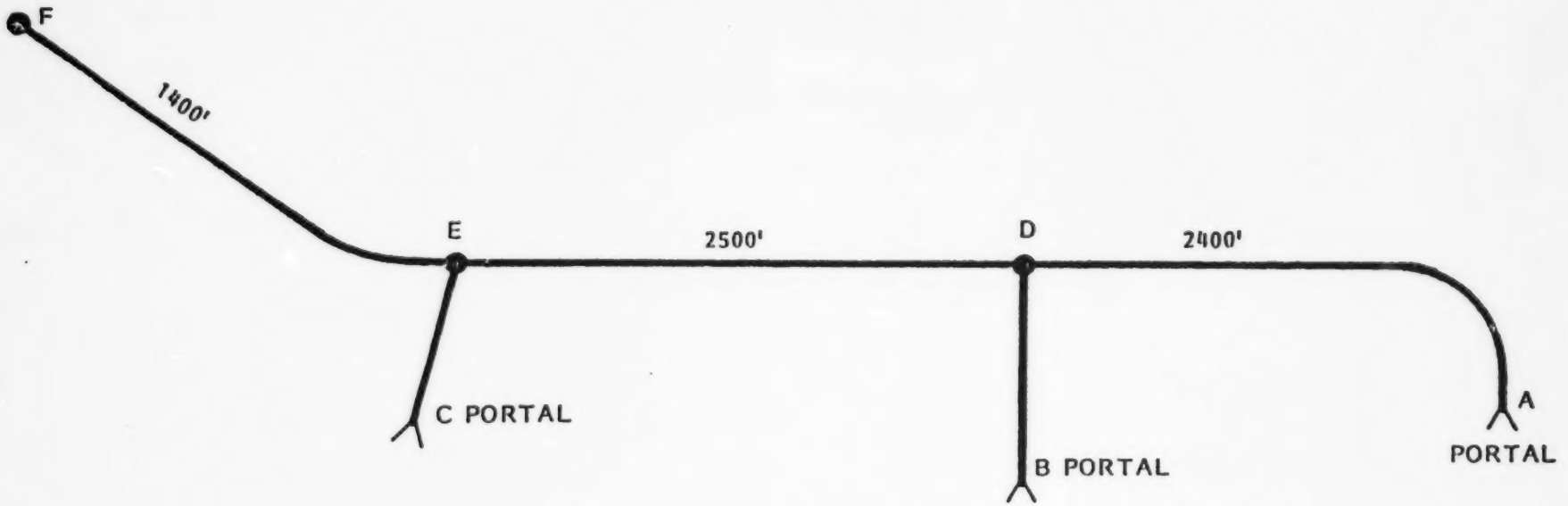
8' x 16' DRIFT CROSS SECTION

FIGURE II



7' x 30' DRIFT CROSS SECTION

FIGURE III



MINE ACCESS TUNNEL LAYOUT

FIGURE IV

A Modern Approach To Underground Core Drilling

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Vice President - Drilling
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November 5th, 1976

Abstract

The rapid advancement of mining technology has resulted in highly mechanized mining operations. The underground environments associated with these mining operations have changed greatly from those of the past. This article outlines our approach to providing core drilling services which are compatible with modern mining methods. The development of our hydraulic core drill (Superdrill) will be discussed and some of our achievements with the drill will be presented.

Introduction

With one possible exception, the basic design of underground diamond drills has not changed since the late 1930's. Drills designed for short boreholes, to approximately 500 feet in depth, are generally bar mounted screw feed air powered drills. For drilling deeper boreholes underground, the industry has relied on modified surface drills. Both of these drill types are severely handicapped when drilling steeply inclined up-holes. These drills also require large, costly excavations because of their physicial dimensions and operational characteristics. In order to make the best use of underground excavations, a large number of ore bodies are presently being examined from exploration drifts located below these potential ore bodies. If the ore bodies prove economical, these exploration drifts become part of the production facility. This preference has resulted in a great need for core drills that can efficiently drill steeply inclined up-holes.

The Evolution of Superdrill

By 1970 we had experienced all the usual problems of drilling with compressed air behind mining crews in large trackless headings. Low air, no air, conflicts with mining crews, all demanded a solution.

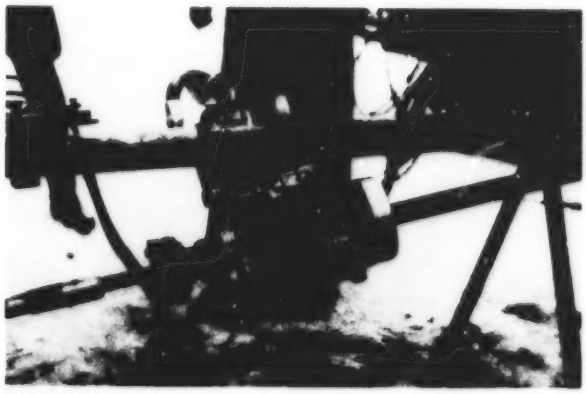


FIGURE 1
Screw feed drill with hydraulic motor.

Also, we were becoming concerned with the inefficient compressed air power system. Therefore our initial project was to decrease costs and to increase productivity by converting an existing air powered diamond drill to a diesel hydraulic powered drill. The prototype drill was tested at Alwin Mine in British Columbia. It became obvious, after initial testing, that the performance of the drill was much superior to the equivalent air

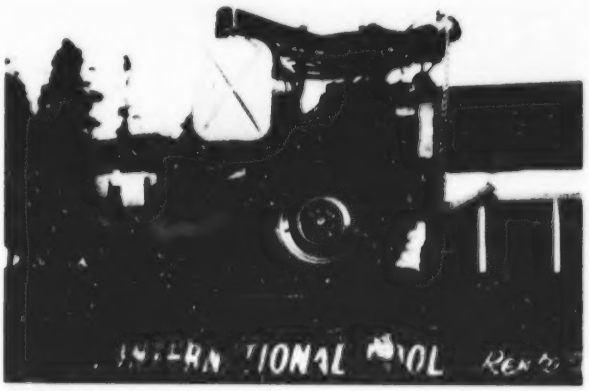


FIGURE 2
Diesel hydraulic power plant for screw feed head.

powered drill, but unfortunately the drill head failed repeatedly. The screwfeed hydraulic drill is presented as Figures 1 and 2.

After initial testing we decided to design and construct a drill that would be highly productive at core drilling in a trackless underground mine. The drill was to have the following characteristics:

1. SELF PROPELLED—TO ELIMINATE THE USE OF LHD EQUIPMENT DURING MOVES.
2. PHYSICALLY DESIGNED TO ACCOMMODATE THE DRILLING OF STEEPLY INCLINED UP-HOLES.
3. SHORT DRIVE TUBE TO REDUCE STATION CUT-OUT REQUIREMENTS.
4. HIGHLY PRODUCTIVE WHEN DRILLING.

Consideration was given to the utilization of existing drill components in the new drill. However, after examing the drill heads available, we decided to design and construct a drill head to our own specifications. The prototype drill, which became known as Superdrill, was completed in July, 1972. Superdrill was tested and placed on a contract coring program. After overcoming many obstacles we redesigned the drill. Completed on May 29th, 1974, the new Superdrill was the first of our present model 100 series.

Since May, 1974, we have examined operational environments for various large underground programs and customized equipment using the basic Model 100 Superdrill head. We have discussed the different configurations elsewhere in the text.

We have recently produced a smaller diamond drill model TD 20 Superdrill, and are presently working on a high torque drill head which will be known as Model 200.

Design Features of Superdrill

Superdrill was designed with the following hydraulic features:—

1. ROTATION
2. FEED
3. ROD CLAMP
4. CHUCK
5. WATER PUMP
6. WIRELINE HOIST
7. DRILL HEAD POSITIONING
8. CARRIER DRIVE
9. ANCHORAGE SYSTEM

Customizing for Adaptability

In the past we examined the operational environments of specific large core drilling programs and customized our Superdrills accordingly. As a result we have developed core drills which are very effective for use in conjunction with the three general types of mine development. Minor modifications are usually necessary to accommodate unique property conditions.

A. Trackless Mines

For the trackless underground mines, we primarily use a track laying mobile carrier shown in Figure 3. The drill can be completely diesel

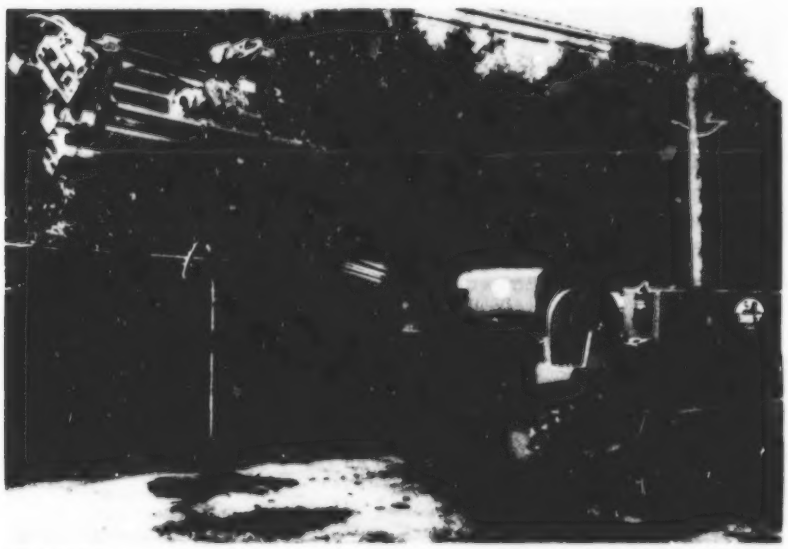


FIGURE 3
Diesel powered track laying Model 100 Superdrill.

powered, which requires the least amount of back up support, or can be diesel powered for mobility and electrically powered for the drilling process. This basic unit was designed for holes of approximately 500 feet in depth but it has drilled AQ boreholes over 1,400 feet in depth.

The necessity for drilling short boreholes to 100 feet depth in very hard rock has led to the development of our Model 20 Superdrill which is mounted on a farm tractor. The drilling functions of this drill shown in Figure 4, are powered by an electric motor which is compatable with the mine development plan of utilizing electric hydraulic development jumbos.

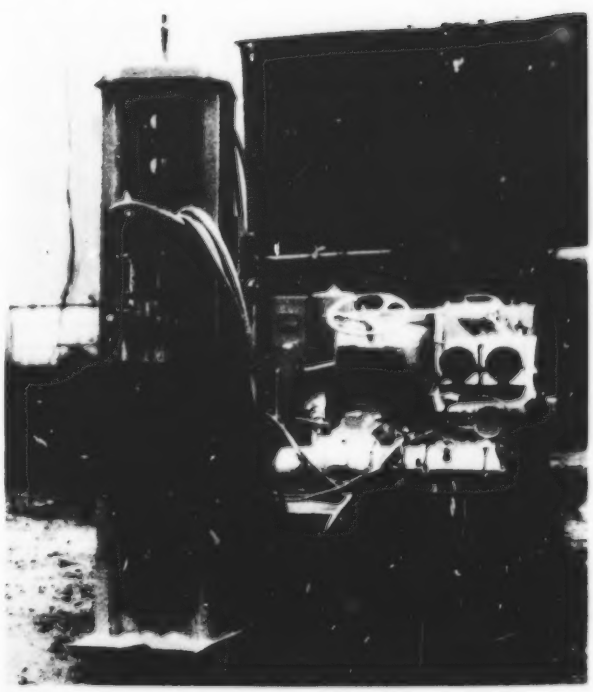


FIGURE 4
Electric TD 20 Superdrill on tractor.

B. Wide Gauge Track

A number of the large ore bodies being extracted by block caving methods rely on track haulage drifts for underground transportation. For operating in these mines we have developed our Rail Electric drill shown in Figure 5. All drilling functions of this unit are powered by an electric motor.

FIGURE 5
Rail electric Model 100 Superdrill.

C. Narrow Gauge Track

Narrow vein ore bodies continue to be developed by small headings and small internal shafts serviced by narrow gauge rail. For these operations, we developed a skid mounted electric drill consisting of a power package, a skid mounted feed frame, and an operator's panel. Figure 6 shows this unit in operation.

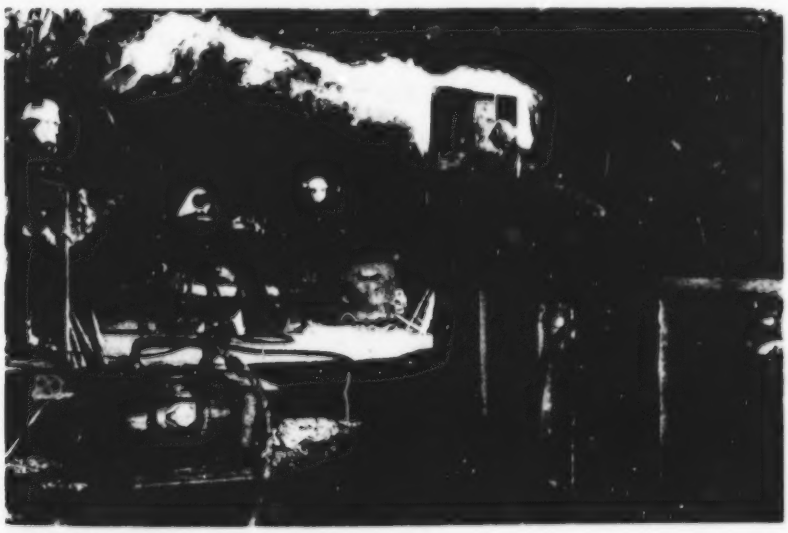


FIGURE 6
Electric Model 100 Superdrill skid-mounted.

Advantages of Superdrill

A. Productivity

Perhaps the biggest advantage of our Superdrills over conventional drills is the increase in productivity. The increase in productivity is achieved through the introduction of new systems and the increase in horsepower used in the drilling process. We have been successful in coring most formations at penetration rates in excess of 12 inches per minute and in some instances penetration rates have been as high as 30 inches per minute.

The following table shows the location of properties on which Superdrills have been used and the productivity ratio when compared with conventional drills. It should be pointed out that productivity records have been established on all properties on which these drills have operated.

Mine	Location	Productivity Ratio
Agnew Lake Mine	Ontario	N.R.C.
Canadian Tungsten Mine	N.W.T.	1.41
Climax Mine	Colorado	1.73
Grum Project	Y.T.	1.48
Henderson Mine	Colorado	N.F.P.
Homestake Mine	S. Dakota	1.69
Lakeshore Mine	Arizona	2.28
Miami East Mine	Arizona	1.63
Wesfrob Mine	B.C.	1.75
White Pine Copper Mine	Michigan	1.60

Productivity Ratio — Feet per shift Superdrill divided by feet per shift conventional drills.

N.R.C. — No reliable comparison due to lack of information on conventional drills.

N.F.P. — Not for print.

Some of our productivity highlights to date have been:

ONE MACHINE MONTH	6488 FEET
ONE DAY	410 FEET
10 HOUR SHIFT	261 FEET
8 HOUR SHIFT	240 FEET
8 HOUR SHIFT (vertical up-hole)	180 FEET

Besides the obvious advantage of obtaining information quickly for decision making, high productivity can also greatly reduce support costs. The reduced support costs can come in the form of a reduction in labour force, or a rapid completion of a drill program.

B. Flexibility of Sequences

The mobility of our drills and the ability to set up and drill upholes at ease has introduced a new dimension to the scheduling of boreholes. This flexibility of scheduling enables the geologist to drill some boreholes which were not economically justified in the past. Figure 7 shows a typical set-up on a nearly vertical up-hole. This set-up can be achieved in 2 man hours; whereas the staging required for a conventional drill might take in excess of 30 man hours.

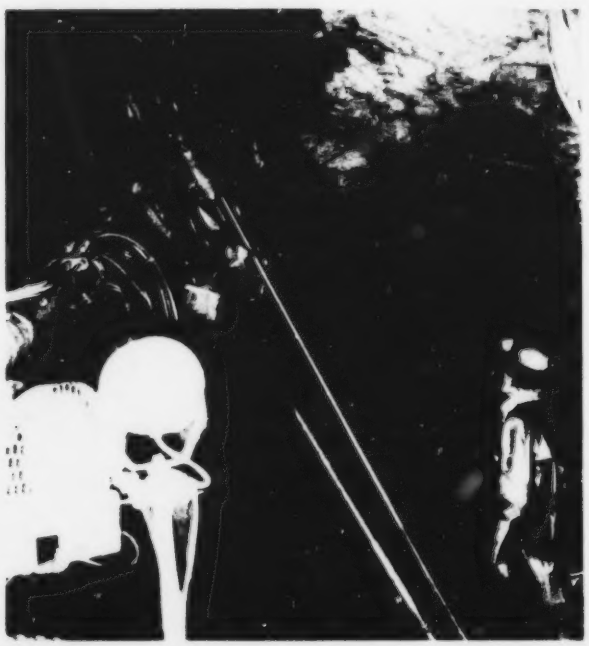


FIGURE 7
Typical set-up for steep up-hole.

C. Power Options

Superdrills can be powered by air, diesel, or electrical motors. To date most units have been powered by diesel engines or electrical motors. For short boreholes widely spaced the diesel powered unit is superior because of its mobility. The drill units which utilize electrical power for the drilling cycle do however, create a superior drilling environment as noise levels are lower and exhaust fumes eliminated. Future units will no doubt combine a small diesel engine for moving the drill and an electric motor for providing the drilling functions.

D. Straighter Boreholes

By rotating the rods at up to three times conventional speed, we have experienced less deviation than boreholes drilled with conventional drills. This phenomenon is evident on the two properties where significant records are available for comparative purposes. Figure 8 shows a plot of borehole deflection versus borehole depth for both a Superdrill and an air powered drill.

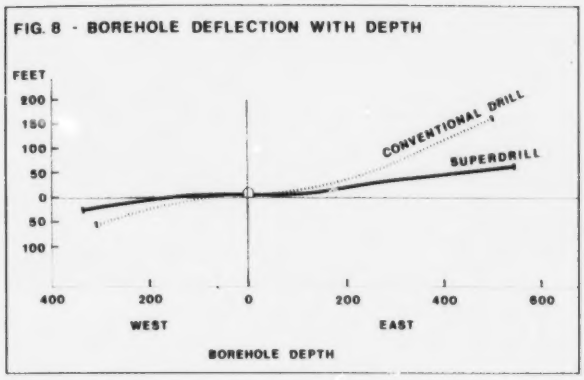


FIGURE 8
Borehole deflection with depth.

E. Longer Bit Life

Much experimental work has been done over the past few years on the diamond drilling process. Both Spink (1972) and Marx (1973) have presented valuable test data from experimented test drilling. On our Superdrill we have infinite control of both pressure and rotating speeds and should achieve optimum bit life. We have also found resonant vibrations in the drill string when approaching the upper limit of rotational speeds for conventional drills. By increasing our rotational speed considerably above this level, vibrations are reduced and better core bit performance results. It is difficult to place quantitative numbers on the increase in bit performance through the use of our Superdrills as all test work has been performed under field operating conditions. The limited values available indicate that bit life is increased by 10% to 20%.

Conclusion

We have developed a line of hydraulic core drills for use in a highly competitive contracting business. These drills have been designed to operate effectively in modern underground environments. To date we are encouraged with the increases in productivity that have been achieved. The interest and support of the mining companies with whom we have been associated, have contributed greatly to the development of our Superdrill.

References

(1) Spink, K. The Nature of the Diamond Drilling Process, INDUSTRIAL DIAMOND REVIEW, page 230-242, June 1972.
(2) Marx, C. Evaluation of the Diamond Drilling Process, INDUSTRIAL DIAMOND REVIEW, page 421-429, November 1973.

First Annual Underground Operators' Conference
Sudbury, Ontario Feb. 25 To 28, 1975

Drainage Tunnel Driving At Granduc

George Vooro, Vice-President, Operations
Canadian Mine Services Ltd.

GENERAL

This paper gives the general summary of a reasonably high speed track drift development as carried out from May-October 1966 by Haste Mine Development Ltd., a subsidiary company of Canadian Mine Services Ltd., at the Leduc camp of the Granduc Operating Company.

LOCATION AND CLIMATE

The location of the tunnel portal is at the Leduc Camp area, which is approximately 35 miles N.W. of Stewart, B.C., at the head of Leduc River and near the base of the Leduc Glacier. The topography of the area is extremely rugged with peaks rising 7000' above sea level. The annual rainfall is heavy, and snowfall may be up to 800-1000 inches per year. As much as 3' of snow may fall in a 24 hour period.

ACCESS

The main access was by fixed wing aircraft or helicopter from Stewart, B.C. Landings were to airstrips located on glaciers or at the base of mountains.

Most of the heavy freight and fuel was brought in by the C-46 aircraft, or by Cat trains travelling over mountainous terrain and glaciers. The communication was by multi-channel radio telephone.

The frequency of flights bringing in fresh supplies, parts, mail, and personnel was often interrupted up to 10 days due to bad weather conditions.

HISTORY

At the time of this development work, the Granduc Operating Company was preparing the property for production.

A major portion of the preparation work was providing access to the mine via a ± 60,000' tunnel connecting the mill at the Summit Lake Camp with the mine near the Leduc Glacier, and drainage from the mine exiting at the base of the Leduc Glacier.

Duplicate tunnel driving plants were set up at the Leduc and Summit camps in the fall of 1964 in order to excavate the long tunnel simultaneously from both ends.

On February 18, 1965, an avalanche struck the Leduc camp and plant, which resulted in the loss of 26 lives and destruction of the plant.

This necessitated stoppage of work at the Leduc camp for a year, and driving of the long access tunnel entirely from the Summit Lake camp.

In order to reduce delays caused by the avalanche, it was necessary to complete the drainage tunnel before the main access tunnel reached the mine area, and start on mine development as soon as possible.

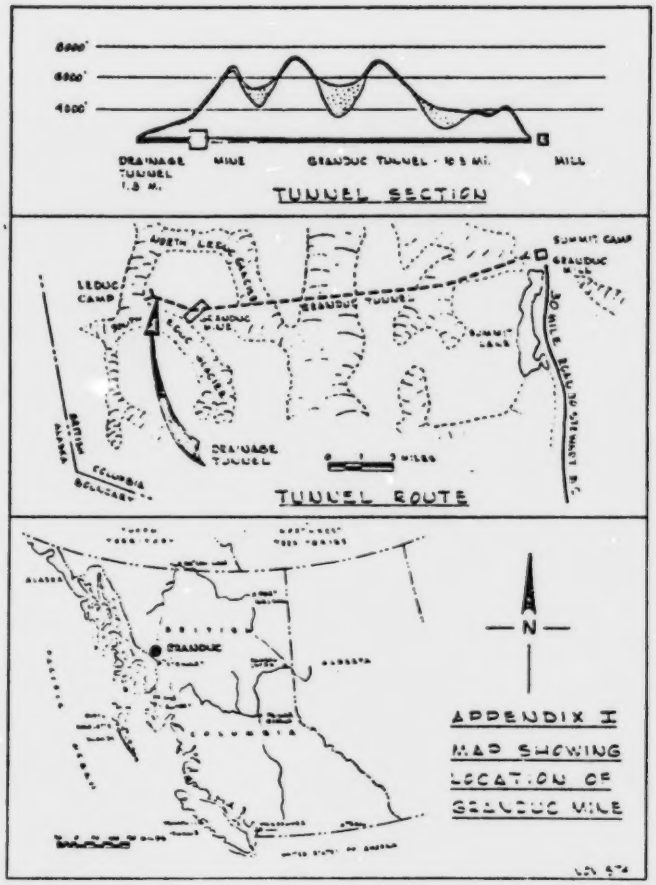
G. "GEORGE" VOORO

He started his mining at Campbell Red Lake Gold Mines in 1946.

His past experience includes years as practical miner working for such well known mining companies as Giant Yellowknife Gold Mines, Pioneer Mines, and Bralorne Mines.

In 1963 he and several associates formed a contracting company, known today as Canadian Mine Services.

He is a partner in a Mine Development, Engineering, and Service Company with head office in Vancouver, and projects in Canada, U.S., and Abroad. He is a member of C.I.M. Vancouver Branch, and the C.I.M. National Body.



The Leduc camp was reactivated for summer use only, additional equipment and supplies freighted in, and contract let for the excavation of the drainage tunnel to commence in May, 1966.

DRAINAGE TUNNEL

The total length of the drainage tunnel was to be ± 7000' of which approximately 850' had been excavated prior to the avalanche. This left approximately 6150' of drainage tunnel still to be excavated during the 1966 season, plus the necessary cut-outs for the Canton switches, and train by-passes.

The mobilization took place during late April-beginning of May, and the intitial crews arriving on site May 10. The plant set-up and preparation work was carried out during most of May with the actual excavation getting underway during the last few days of May.

The planned size of the tunnel was 11.0' high by 9.0' wide, but this was changed to 12.0' high by 10.0' wide, in order to accomodate equipment, services and personnel.

The equipment contingent used was as follows:

Tunnel Driving Plant:

1 — 4 boom, 2 deck, track mounted Gardner Denver Jumbo with DH 123 drills and 6' feed slides.
1 — Eimco 40H mucker c/w double flange wheels.
2 — Goodman 8 ton battery Locos with changing units, chargers, and spare batteries.
10 — 10 ton Granby side dump cars fitted with 5th wheel for dumping.
1 — 30" x 50 HP Joy axivane fan
2 — Flat cars for rails, and pipes
1 — Explosives car
2 — Air-operated Canton switches
1 — Water supply pump
Misc. Hand held drills and small tools

Surface Plant

4 — Copco 600 CFM compressors
2 — Volvo 75 KW generators
1 — Crew crummy
2 — Pick-ups
1 — Cat 977 loader
1 — Cat D-6 tractor
1 — 6 x 6 5 ton dump truck
2 — Bombardier snow vehicles
1 — 350 Amp welder
2 — Muck dumping cylinders, mounted
Misc. Shop tools

Consumable Supplies

Drill Steel — 6' x 1.25 Rope thread, coupled for 12' holes
Drill Bits — 1 7/8" x 1.25 Rope thread, for blast holes
— 2¼" x 1.25 Rope thread, for cut holes
Explosives — 1½" x 16" Cilgel B
Caps — LP V's with 14' leg wires

Installed Services

Fan pipe — 30" diameter x 25' long, Spiralok construction
Air pipe — 8" diameter x 20' long, victaulic
Water pipe — 2" diameter x 20' long, victaulic
Rail — 60 Lbs. x 33' long
Track guage 48" with 6" x 8" ties at 30" centers

Several crew contingents were tried, and the following gave the best performance and efficiency:

CATEGORY	DAY	AFTN.	NITE	GRVYD.
Project Mgr.	1			
Clerk First/Aid	1			
Foreman			1	
Working Shift Boss	1	1		1
Miners	4	4		4
Trammers	2	2		2
Dump - Explosives Man	1	1		1
Cat Operator	1	1		1
Track Crew	2			
Labourers	1	1		1
Mechanics - Tunnel	1	1		1
- Shop	2	1		1
Total Crew ± 40 Men	17	12	1	12

The Catering, Engineering-Geology, and Warehousing was provided by the Granduc Operating Company.
The basic work cycle was made up of the following procedure:

(Assume a clean face)

(A)	Move in the Jumbo, set up	15 Min.
(B)	Drill 34-12' holes	90 Min.
(C)	Load round, move out Jumbo	30 Min.
(D)	Blast and clear smoke	30 Min.
(E)	Move in mucker, cars	15 Min.
(F)	Muck out round	90 Min.
(G)	Move out mucker	15 Min.
	Complete basic round	285 Min.
(H)	If track was installed	30 Min.
		315 Min.

Completed Basic Round — 4 Hrs. 45 Min.
Completed Basic Round & Track — 5 Hrs. 15 Min.

All other services were installed during the drilling cycle by others, and hook-ups made during the loading of holes.

Ground support was minimal, and installed only when needed.

Canton switch cut-outs were approximately 300' apart, lay-by's approximately 3000' apart.

All rounds were drilled with a 2 deck Jumbo with 4 Gardner Denver DH 123 drills using 6' feeds, and coupling steel to achieve 12' holes. Four drillers were used, and each driller had approximately 8-9 holes to drill. The cut was drilled from the lower deck and looking slightly up. Total holes drilled were 34, and the penetration rates ranged from 12" to 24" per minute. Average drill-off time was 90 minutes.

Rounds were loaded using 5 miners (4 drillers and shift boss), and it was completed in 30 minutes. Blasting was done electrically using 220 volts. Crews travelled to the nearest lay-bye for blasting, and waited for approximately 30 minutes before returning.

The ventilation was incasted through the fanpipe, and exhausted out through the tunnel. Reversing of fans was attempted during blasting cycle, but resulted in longer delays, and damage to scavanger fan at the face. Had the main fan been of a larger capacity, the incasted ventilation through the tunnel would probably have been more successful.

When returning after the blast, one miner started scaling, one remained at the Canton switch to help switch cars, one did the mucking, and one helped near the mucker with coupling of cars and looked after the 2" air hose. Two trains of cars were used with a trammer on each train, and the train consisted of 5 cars.

While a car was being filled, an empty car was put on the Canton switch. The train returned to the face to pick up the full car, go back to the Canton switch to get the empty car. and continue, using the same sequence. When trains come in for the mucking cycle, it is important that one car

is spotted ahead of the Loco, and the rest of the cars behind the Loco. This eliminated delays in switching and uncoupling of cars.

Minimal amount of ties were installed during the mucking cycle, and track kept approximately 8"-12" low. During the installation of track, all ties were laid down to proper elevation, track lifted behind, and new section of rail installed. The double flanged wheels on the mucker necessitated the welding of double slide rails, and these were worn out and bent after 3-4 weeks of use.

Dumping of cars was done by a mounted air cyclinder, and this mounting was positioned on a parallel track for mobility. One man was used for this work. He also made up primers for blasting, and looked after the transfer of explosives to the explosives car.

A separate track crew was used to level track, and install ditch. This was normally done within 1000' of the advancing tunnel heading.

Heavy inflows of water were encountered at approximately halfway point, and resulted in the grade climbing at a rate not acceptable. Rather than stop and slash to get back on the grade again, it was decided to advance at a slightly lesser grade, get back to projected grade, and correct the tunnel floor after completion of the excavation. This proved to be a wrong decision, and resulted in major accumulation of water on the track during the rest of the excavation. The grade correction was carried out during the last weeks of the contract.

General Performance Data

Arrive on site (Initial Crew)	May 10, 1966
Commence excavation	May 20, 1966
Suspend excavation (winter conditions)	November 16,1966
Total footage excavated (Incl. slashing)	6,355'
Footage firsthalf of contract (May 20-Aug. 15/66)	3,715'
Footage last half of contract (Aug. 16-Nov. 16/66)	2,640'
Best footage achieved in 24 Hr. period	62'
Best calendar month advance (July 1-31/66)	1,576'
Average advance per day, Development only	39.72'
Average advance per day for complete project, incl. grade correction	31.62'
Average feet per man shift — Contract Miners	2.27'
Average feet per man shift — total Crew	0.80'
Average feet drilled per ft. of advance	33.8'
Explosives used per ft. of advance, Lbs.	29.2
Total feet drilled for the project	214,987'
Total explosives used for the project. Lbs.	184,590
Total manshifts — Contract Miners	2,802
— Support Crew	4,264
— Mobilization and delay	880

Summary and Conclusion

It is possible to achieve a very good performance in mine tunnel excavation using standard track type equipment instead of the high speed custom designed equipment.

Several factors are important in sustaining performance, once achieved:

(a) Adequate contingent of equipment, spare equipment, and parts.

(b) Scheduled holidays for crews and supervision to eliminate fatigue.

(c) Sufficient planning must take place to overcome logistics problems which will surface in all projects that are by nature or location not ordinary.

(d) Constant check on dimensions, lines, and grades by the Engineering staff throughout the project, and immediate correction of any variances once these are evident.

Analyzing the project in retrospect, and having had other variations to cope with after the Leduc Drainage Tunnel excavation, the writer believes that the most important single factor on a project of this nature is the selection of the project manager. This individual, given the proper tools and backup, will attract the right calibre of crew and ensure the best performance possible under the circumstances.

The second most important factor would be the provision of backup equipment, parts, and maintenance. It is not enough to provide spare parts as this will result in downtime and deteriation of crew's morale. The cycling of work sequences will not allow for adequate preventative maintenance of a continuous use basis, and will result in equipment downtime.

The third most important factor would be the scheduled time off or holidays for the crews. The most common downfall of a project is the loss of manpower even after the productivity has been good. This can be eliminated by a ridgidly enforced holidays, starting shortly after commencement of the project.

This completes a brief summary of the Leduc Drainage Tunnel project. The writer expresses his sincere thanks to the Granduc Operating Company Lfd. for permitting this data to be published, and in doing so will benefit some other Mine Developer in their planning.

[illegible] DEVELOPMENT LTD., LEDUC DRAINAGE TUNNEL

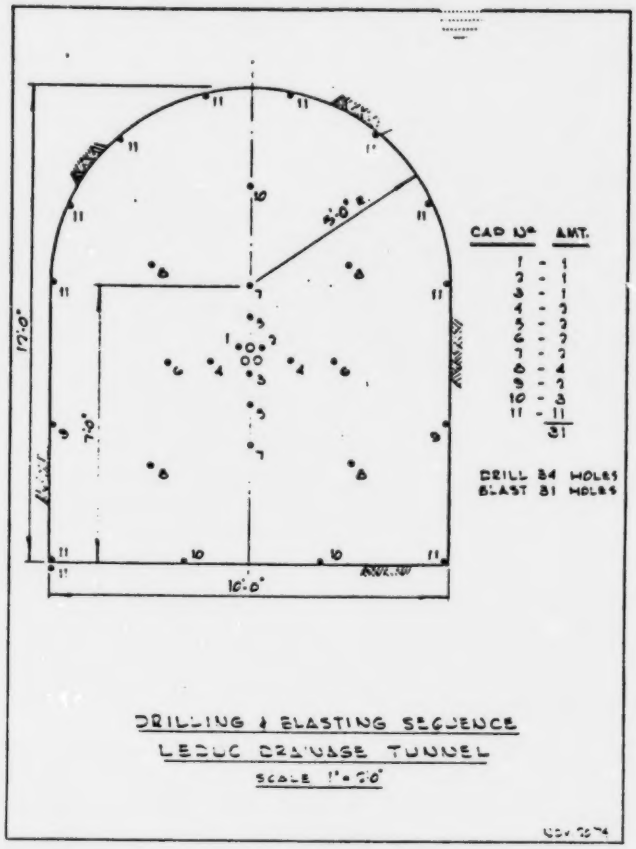
Period	Advance per period	Feet from Portal	Ft. Drilled	Explosives used Lbs.	Feet Drilled Per Ft. Advance Year to Date	Explosives Lbs./Ft. Year to Date	Remarks
May 16 - May 31	161	1011	5400	4200	34.6	26.1	
June 1 - June 15	638	1649	19334	16750	31.1	25.5	
June 16 - June 30	772	2421	23252	18832	30.6	25.0	
July 1 - July 15	737	3158	25400	21596	31.0	26.4	
July 16 - July 31	839	3728	26428	21600	31.1	26.1	260° Steel Set by-Pass
Aug 1 - Aug 15	568	4296	19900	21850	31.7	27.0	
Aug 16 - Aug 31	467	4763	17214	15275	32.2	28.5	
Sept 1 - Sept 15	553	5316	21474	18886	32.1	29.0	
Sept 16 - Sept 30	482	5800	17994	14675	32.4	29.0	
Oct 1 - Oct 15	570	6357	20244	17200	32.5	29.1	
Oct 16 - Oct 31	253	6610	8172	6375	32.5	29.0	Install Timber & Steel Sets
Nov 1 - Nov 15	2**	6836	12866	9180	32.9	29.1	Install Timber & Steel Sets
Nov 16 - Dec 6	-	6836	-	-	-	-	Grade Correction
Summary	6355	6836	214,987	184,590	33.82	29.2	

References:

Tunnel Driving at Granduc — by N. Gritzuk — CIM Annual Meeting 1968

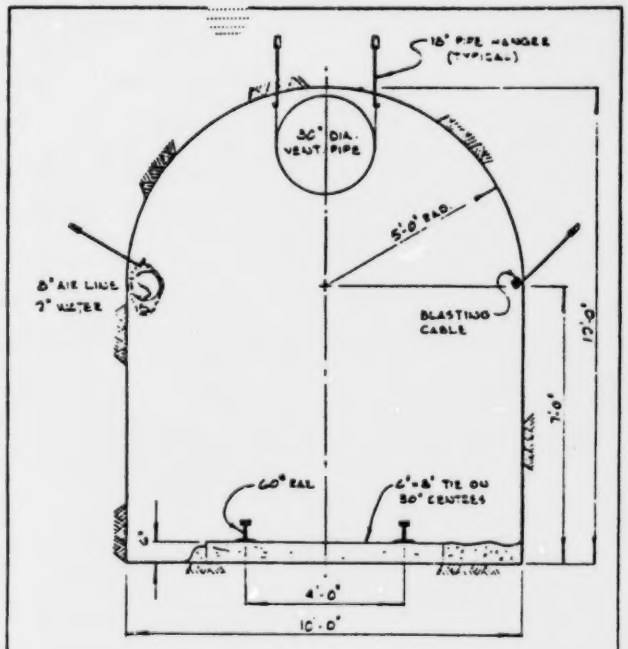
Granduc Operating Company Engineering Department

Canadian Mine Services Engineering Department



DRILLING & BLASTING SEQUENCE
LEDUC DRAINAGE TUNNEL
SCALE 1" = 10'

NOV 15 '74



CROSS SECTION
LEDUC DRAINAGE TUNNEL
SCALE : 1" = 7'-0"

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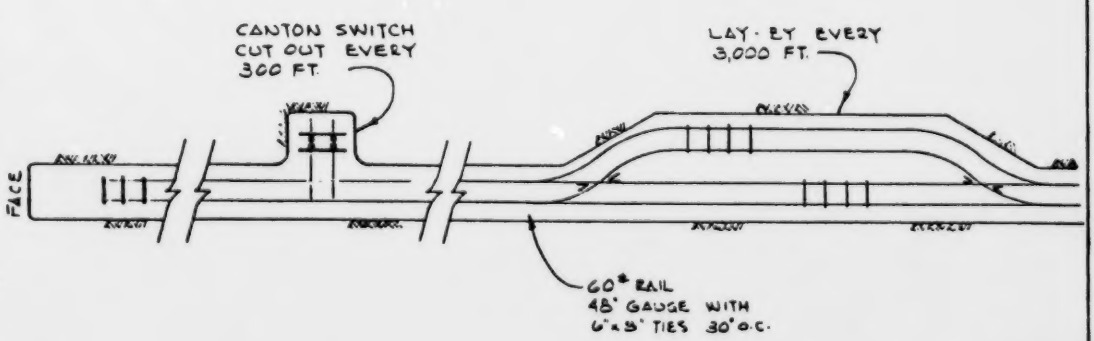

LEDUC DRAINAGE TUNNEL
TYPICAL LAYOUT SHOWING CANTON
CUTOUTS AND LAY-BYS
SCALE: APPROX. 1" = 20'

NOV 15 '74

POOR

QUALITY

ORIGINAL